JOURNAL

OF

THE FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA

FOR THE

PROMOTION OF THE MECHANIC ARTS.

JANUARY, 1855.

CIVIL ENGINEERING.

*On the Strength of Locomotive Boilers and the Causes which Lead to Explosion.**† By WILLIAM FAIRBAIRN, F.R.S.

A difference of opinion having arisen between a gentleman high in authority and Mr. Fairbairn, concerning the causes of an accident which took place through the explosion of a locomotive engine at Manchester, on the eastern division of the London and North-Western Railway, a series of experiments was instituted by Mr. Fairbairn, not for the purpose of confuting the arguments of others or confirming his own, but to determine the real causes of the explosion, and to register the observed facts for our future guidance in guarding against such fearful catastrophes.

After a careful examination of the boiler a few hours subsequent to the explosion, one side of the fire-box was found completely severed from the body of the boiler, the interior copper box forced inwards upon the furnace; and with the exception of the cylindrical shell which covers the tubes, the whole of the engine was a complete wreck.

Mr. Ramsbottom, the Locomotive Superintendent, in his Report to the Directors, states that "the engine in question was made by Messrs. Sharp, Roberts & Co., in the year 1840, has been worked at a pressure of 60 lbs. per square inch, and has run in all a distance of 104,723 miles, a great part of which has been either entirely without load, or nearly so. As the cylinders are only 13 inch diameter, it has been for some time too light to work any of our trains; and has therefore been chiefly employed

* Extracted, by permission, from the forthcoming Volume of the 'Transactions' of the British Association for the Advancement of Science.

† From the Lond. Civ. Eng. and Arch's. Jour. June, 1854.

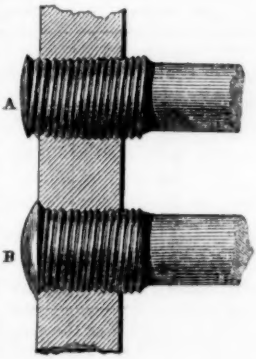
since 1849 in piloting the trains through Standedge tunnel, along with another engine of the same size, which is now at work.

"The fire-box was originally $\frac{7}{16}$-inch thick, and is now a little over $\frac{6}{16}$-inch; and from its excellent condition, might well be supposed (as indeed it was by Mr. Sharp, of the firm of Sharp Brothers & Co., who inspected it a few days after the accident) to have been recently put in new. It is perfectly free from flaw or patch, and would certainly have run at least 100,000 miles. The same may also be said with respect to the outer shell, which is nearly of the original thickness. The engine had been in the repairing shop the three months previous to the accident; and the iron fire-box stays, about which so much has been said, were tested by the hammer in the usual way, and were considered, both by the workmen and the foreman, Wheatley, to be all sound. When originally made, they were $\frac{1}{16}$ths in diameter, and were equal to a strain of at least ten times the force they had to sustain. With the exception of one stay, which was on the top row, the one most reduced from oxidation was half-inch diameter; and supposing the hold on the copper box to have been good, it was capable of resisting a strain of rather more than $6\frac{1}{2}$ times the working pressure, equal, say, to 390 lbs. per square inch. The only point, therefore, which could admit of doubt as to the safety of the boiler, was with respect to the hold which the stays might have in the copper box; but it appears, from experiments since made, and which have been repeated by Mr. Fairbairn, that from the force required to pull some of the old stays out of a copper plate similar to the fire-box, into which they had been screwed by the *old threads only*, and *not riveted*, the boiler could not have burst under a pressure of less than 300 lbs. per square inch. One of the old stays, which had had the thread partially damaged from being ripped out of the copper box by the explosion, was screwed by hand into a copper plate, by the old thread, to a depth equal to the thickness of the fire-box plate, but not riveted, and it required a dead weight of 8204 lbs. to pull it out; and as each stay has to support a surface of 5 inches $\times$ $5\frac{3}{8}$ inches, say 27 square inches only, it follows that a pressure of $8204 \div 27 = 303{\cdot}85$ lbs. per square inch would have been required to strip it. Another stay, which had not been stripped by the explosion, but which was screwed out of the old box, was similarly treated, and required a force of 9184 lbs. to strip it, equal to 340 lbs. per square inch."

Since the experiments here referred to were made, Mr. Fairbairn has repeated them with great care; and taking into account the tensile strength of the stays—in their corroded state—of the side of the fire-box, which to appearance was the first to give way, shows that a force of 380 lbs. upon the square inch would be required to effect rupture; and the results of the experiments on the resistance of stays screwed into the copper fire-box fully confirm those already made by Mr. Ramsbottom. Assuming, therefore, that the end of the screws were riveted, and sound in other respects, we may reasonably conclude that a strain not less than 450 to 500 lbs. upon the square inch would be required to strip the screws, or tear the stays themselves asunder. These facts are founded upon the experiment of the resisting powers of the iron stay screwed into a por-

tion of the copper cut out of the ruptured fire-box, and another experiment of a similar stay first screwed and then riveted, as shown in the annexed engraving.

The stay marked A, ¾-inch in diameter, in the first experiment, required a force of 18,260 lbs.=8·1 tons to strip the screw, and draw it out of the copper; and the stay B, of exactly the same dimensions, but riveted over the end, required a force of 24,140 lbs.=10·7 tons before it was dislodged. Taking, therefore, the mean of those experiments, including those of Mr. Ramsbottom, and we arrive at the results given above,—namely, a resisting power of 785 lbs. on the square inch, to burst or produce fracture in the stays and side of the fire-box.



In locomotive engines of more recent construction, where the stays are thicker and formed into squares of 4 to 4½ inches, the resisting powers will probably be increased to 850 or 900 lbs. on the square inch, that is, seven or eight times the working pressure.

On a careful examination of the fire-box and every other part of the boiler, it was found that the stays and copper were perfect, and that they were able to sustain a pressure much exceeding 207 lbs. upon the square inch, as given in the following table.

In these experiments, the top of the fire-box sank a little, owing to the breakage of a bolt of one of the cross-bars; but the fire-box stays were quite perfect, and to every appearance would have sustained nearly double that pressure. If the fire-box stays had been new and the top well-stayed, it is more than probable that a force from 800 to 900 lbs. on the square inch would have been required to cause rupture.

As much stress has been laid upon the weakness of the stays which unites the flat surface of the boiler to the sides of the fire-box, the following experiments clearly indicate that the fire-box stays are not the weakest parts of a locomotive boiler, and that we have more to fear from the top of the furnace, which under severe pressure is almost invariably the first to give way. Great care should therefore be observed in the construction of this part, as the cross-beams should not only be strong, but the bolts by which the crown of the fire-box is suspended should also be of equal strength, in order that no discrepancy should exist, and that all the parts should be proportioned to a resisting force of at least 500 lbs. on the square inch.

Finding the knowledge with regard to the power of resistance of locomotive boilers to strain exceedingly imperfect, Mr. Fairbairn availed himself of the present opportunity, to determine by actual experiment the laws on which these powers are founded; and for this purpose the Directors of the London and North-Western Railway Company placed in his hands an engine of the same age, constructed by the same makers, and in every respect a fac-simile of that which exploded. This engine was subjected to hydraulic pressure as follows:—

TABLE I.—*Experiment made May 4th, 1853, to determine the Resisting Powers of the Fire-box and Exterior Shell of No. 2 Engine on the Eastern Division of the London and North-Western Railway.*

Number of pounds on scale.	Weights per sq. inch upon the valve.	Number of pounds on scale.	Weights per sq. inch upon the valve.
Lever	35·0 [1]	5½	132·5
Scale	50·0	6	140·0 [3]
½	57·5	6½	147·5
1	65·0	7	155·0
1½	72·5	7½	162·5
2	80·0	8	170·0 [4]
2½	87·5	8½	177·5
3	95·0	9	185·0
3½	102·5	9½	192·5
4	110·0 [2]	10	200·5
4½	117·5	10½	207·5 [5]
5	125·5		

[1] This engine was the same age, and had run about the same number of miles as the exploded engine. The fire-box was considerably sunk or bulged, and the rivets as well as the stays much weakened. The engine had been at work since 1840.

[2] With this pressure a leakage was observed at some of the joints.

[3] Leakage increased.

[4] Leakage still increasing.

[5] With this pressure one of the bolts of the cross-bar over the fire-box broke, which caused the experiment to be discontinued, as the leakage was greater than the force-pump could supply.

In this experiment, the boiler was furnished with a valve, 1 inch area, and a lever of suitable dimensions. This lever, 15 : 1, gave as the weight upon the valve 35 lbs., and having suspended the scale, which indicated with the lever 50 lbs., the following results were obtained :—

From the above, it is evident that the boiler which led to these experiments could not have burst under a pressure of less than 300 to 350 lbs. upon the square inch, as the failure of a single bolt in one of the cross-bearers above the fire-box, under a pressure of 207 lbs. on the square inch, was not the measure of its strength, but one of those accidental circumstances which is calculated to weaken, but not absolutely destroy its ultimate powers of resistance. This conclusion was arrived at from the fact of finding the upper part of the fire-box in every respect perfect. After the removal of the pressure of 207 lbs. on the square inch, and comparing these experiments with the appearance of the crown of the ruptured fire-box, Mr. Fairbairn is confirmed in the opinion that steam of high elastic force must have been present to cause the disastrous explosion which eventually occurred.

Again referring to the Report, Mr. Ramsbottom states,—"That it has been objected that the steam could not have been raised from 60 lbs. per square inch, the pressure at which the safety-valve was blowing off before being screwed down, to the pressure stated by Mr. Fairbairn, in twenty-five minutes ; but although I do not go all the way with Mr. Fairbairn as to the strength of the boiler, I find, from experiments made upon a boiler of somewhat similar dimensions, and placed as nearly as possible under the same circumstances, that the steam was raised from

30 lbs. per square inch to 80 lbs. as shown by Bourdon's steam-gauge according to the following scale, namely,—

			h.	m.	s.					
Safety-valve	screwed	down	3	1	20	=	30	lbs.	per	square inch.
"	"	"	3	2	30	=	35	"	"	"
"	"	"	3	3	45	=	40	"	"	"
"	"	"	3	5	00	=	45	"	"	"
"	"	"	3	6	15	=	50	"	"	"
"	"	"	3	7	20	=	55	"	"	"
"	"	"	3	8	30	=	60	"	"	"
"	"	"	3	9	30	=	65	"	"	"
"	"	"	3	10	30	=	70	"	"	"
"	"	"	3	11	30	=	75	"	"	"
"	"	"	3	12	20	=	80	"	"	"

These experiments, although perfectly satisfactory as regards the time required to raise the steam (under ordinary circumstances of the engine, standing with the fire lighted, and the usual quantity of coke in the furnace) from 30 up to 80 lbs. on the square inch—it was, nevertheless, considered desirable to repeat them through a still higher scale of pressure and temperature, and to ascertain, not only the exact time, but the ratio of increase, and the corresponding temperature of the steam in the boiler as the pressure progressively increased. For these objects, two delicately constructed thermometers were prepared by Dalgetti, and having adjusted Bourdon's pressure-gauge by a corresponding column of mercury, and an engine having been placed at Mr. Fairbairn's disposal, the following results were obtained:—

TABLE II.—*Experiment made May 7th, 1853, to determine the rate of Increased Pressure, Temperature of Steam, &c., in a Locomotive Engine with the Safety-valve screwed down and the Fire under the Boiler.*

Time.	Pressure.	Temperature, No. 1 gauge.	Temperature, No. 2 gauge.	Mean Temperature.
h. m.		°	°	°
2·44	11·75	243	243	243·00
2·45	14·15	247	246½	246·75
2·46	16·35	251	251	251·00
2·47	19·25	255½	255	255·25
2·48	22·35	260	259½	259·75
2·49	25·75	264	264	264·00
2·50	28·95	268½	268¼	268·37
2·51	32·15	273	273	273·00
2·52	35·75	277	277	277·00
2·53	39·95	282	282	282·00
2·54	44·25	286½	286¼	286·37
2·55	48·35	291	291	291·00
2·56	52·75	295½	295¼	295·37
2·57	57·75	300	300	300·00
2·58	63·75	304¼	304¼	304·25
2·59	68·95	308½	309	308·75
3·00	74·75	313	313	313·00
3·01	80·35	318	317½	317·75
3·02	87·25	322	322	322·00
3·03	93·95	326¼	326	326·12
3·04	101·15	331	331	331·00
3·05	108·75	335½	335¾	335·62
3·06	111·75	—	—	—[1]

[1] This experiment was lost, the thermometers not indicating a higher temperature.

Let us now endeavor from this table to discover the law expressing the relation between the time and pressure, or between the time and temperature.* The observations being made at intervals of one minute of time, and the furnace being maintained at the same intensity, it may be presumed that the quantity of heat communicated to the water was uniform, or that there were equal quantities of absolute heat communicated to the boiler in equal times. The column of pressures gives the successive augmentations of pressure at equal intervals, and the column of temperature gives the corresponding augmentations of heat as indicated by the thermometer. The column of pressures shows that the increments of pressure, in equal intervals of time, increase with the temperature; thus at or near 260° the average increment of pressure is at the rate of 3·1 lbs. per minute; at or near 282°, it is 5·4 lbs. per minute; at or near 326°, it is 7·1 lbs. per minute. Mr. Ramsbottom's table of experiments indicates a similar result; thus at or near 268° the average increment of pressure is at the rate of 4 lbs., whereas, at or near 304° it is at the rate of 5 lbs. per minute. The law, therefore, expressing the relation of time and pressure does not appear to admit of assuming a simple form. But the case is different with respect to the law expressing the relation of time and temperature. Thus if T=temperature in degrees, and t=the time in minutes at which this temperature is observed, estimated from the commencement of the experiments, then

$$T = a \times t + b \quad . \quad . \quad . \quad . \quad (1)$$

will give the relation between T and t with great precision where a and b are constants, whose values, derived from these experiments, are

$$a = 4{\cdot}44 \text{ and } b = -486.$$

For example, let t=166, then T= 4·44 × 166—486=251°, which exactly corresponds with the tabular value. Again, let t=180, then T= 4·44 × 180—486=313°·2; in this case the tabular value is 313°. Again, let t=185, then T=4·44 × 185—486=335°·4; in this case the tabular value is 335°·6. From this formula we find

$$t = \frac{T + 486}{4{\cdot}44} \quad . \quad . \quad . \quad . \quad (2)$$

If t=the number of minutes which elapse between the temperatures T and T′, then we find from 29 (1,)

$$T' - T = 4{\cdot}44\, t' ; \quad . \quad . \quad . \quad . \quad (3)$$

which shows that *the temperature increases with the time;* and presuming that the heat of the furnace remained constant, this formula also shows that *equal increments of absolute heat produce equal increments of sensible temperature as indicated by the thermometer.*

To determine the time, estimated from a given pressure, at which the boiler would burst.—

1st. Let the given pressure be that of the atmosphere, and let the boiler be able to sustain 240 lbs. pressure per square inch. From an experimental table of pressures and temperatures, we find 240 lbs. pres-

* The mathematical analysis of this question was supplied by Mr. Tate.

sure to correspond to 403° temperature, and 15 lbs. pressure to 212° temperature; hence we have by formula (3,)

$$t' = \frac{403 - 212}{4{\cdot}44} = 43 \text{ minutes},$$

which is the time in which the boiler would burst, estimated from the time at which the water begins to boil.

2d. Let the given pressure be 60 lbs. per square inch, and the boiler-pressure 240 lbs. per square inch, then

$$t' = \frac{403 - 296}{4{\cdot}44} = 24{\cdot}1 \text{ minutes.}$$

3d. Let the given pressure be 60 lbs. per square inch, and the boiler-pressure 300 lbs., then

$$t' = \frac{422 - 296}{4{\cdot}44} = 28 \text{ minutes},$$

which is nearly the time in which the boiler experimented upon would burst.

These facts appear to be sufficiently conclusive to enable us to judge of the dangers to which people expose themselves under circumstances where the necessary precautions are not taken for allowing the steam thus generated with fire under the boiler to escape. The great majority of accidents of this kind have arisen during the time the engines are standing, probably with the safety-valve fastened and a brisk fire under the boiler. How very often do we find this to be the case in tracing the causes of these melancholy and unfortunate occurrences!

(To be Continued.)

For the Journal of the Franklin Institute.

Description of Kensington "Water Works." By Washington Jones.

These works, commenced in the year 1849, under the superintendence of Mr. J. Singerly, were intended to supply the inhabitants of the District of Kensington with water from the river Delaware.

The engine and pump-house is situated on the river, at the foot of Wood Street, in the northern part of the District. It is fifty feet wide by seventy feet long; built of bricks in a neat, substantial manner, with rustic work at the angles; the foundation walls are based upon a solid rock, that lies about eighteen feet below the surface of the ground.

The two reservoirs are situated between Sixth and Seventh Streets, and north of Lehigh Avenue, at a distance, measured on the line of the ascending main, of about thirteen thousand three hundred feet from the pump-house, and at an elevation of one hundred and twenty feet above the level of mean tide.

The bottoms and sides are covered in the usual manner, with bricks set on a bed of well rammed clay puddle. Each reservoir is, on the bottom, one hundred and sixty-one feet wide by two hundred and ninety-six feet nine inches long. The angle of inner slope 35° from a vertical line. The content of each, when filled to a height of twelve feet above

the bottom, is 4,642,026 standard gallons, or, about 100 gallons for each inhabitant of the District.

There are two pumps and engines, with two setts of boilers, so arranged that either engine can be supplied with steam from either sett. Engine and pump, No. 1, was built by Messrs. Brock & Andrews, to designs made from the specifications furnished them by the committee, appointed by the Commissioners of the District from their body to superintend, in conjunction with their engineer, the construction of the works. The engine is non-condensing, with a cylinder 30 inches diameter, 6 feet stroke, lying in a horizontal position, and fitted with balance puppet valves. The boilers built for this engine are six in number, 42 inches diameter, and 40 feet long: and supply steam of 40 pounds pressure per square inch, for ten revolutions of the engine per minute.

The pump barrel is 18 inches diameter, 6 feet stroke, and lies in a horizontal position, about eighteen feet below the steam cylinder, and eight feet below mean tide. It is double acting, with valve boxes similar to those in use at Fairmount Water Works, originally designed by the late Frederick Graff, C. E. Motion is given to the pump piston by the vibrations of a vertical lever beam, whose upper and lower ends are respectively attached by links to the cross-head of the cylinder and that of the pump. The specifications required: "Two receiving and two discharging valves, which will be placed at an angle of 45°; each sett will be divided into four divisions, and of equal or larger capacity than the area of the pump barrel." This condition compelled the valve boxes to be made unusually large. Their dimensions were, three feet ten inches wide, two feet ten inches deep, and nine feet long. Thickness of metal, one and three-quarter inches. So much flat surface was presented to the pressure of the water, with an insufficiency of metal to resist it, that the boxes bursted, soon after being put in operation, of course disabling the whole works. A committee of consulting engineers, after inspection, advised several important alterations and additions to the pumping apparatus and engine, which were made under the superintendence of Wm. E. Morris, C. E. The banks of the reservoir showed symptoms of weakness, and were strengthened in the necessary parts. The subsequent action of the engine has abundantly proved that the changes and additions were judicious and necessary. The consumption of fuel required to keep engine, No. 1, supplied with steam is not positively known, as there have been no conveniences at hand for testing it; but, it is stated by Mr. J. J. Dehaven, Chief Engineer, in his official report to the Commissioners of the District, to be eleven tons in twenty-four hours, when engine averages ten double strokes per minute, carrying steam for the whole stroke, which shows the evaporative efficiency of the boilers to be 4·24 pounds of water, (first warmed by passing through a heater, forming part of the exhaust pipe of engine) converted into steam of 40 pounds pressure, by the consumption of one pound of anthracite coal.

No convenient opportunity has offered for proving the amount of water pumped into the basins, by engine No. 1, in a given time, but, by taking the result of the trial made on engine, No. 2, which gives the amount of water raised, 70·6 per cent. of the space displacement of piston, making, at ten strokes per minute, a total of 1,550,442 standard

gallons raised in twenty-four hours by an expenditure of eleven tons of coal, or about 62·9 gallons, or 522 pounds of water, raised 112 feet high, at a velocity of 120 feet per minute, for each pound of coal consumed.

Engine, No. 2, was built by Messrs. Reaney, Neaffie & Co., and put in operation, August, 1852. It is of the condensing type, and has a cylinder 42 inches diameter, 6 feet stroke, standing in a vertical position. It is fitted with balance puppet valves. The steam is cut off after the piston has traveled seven-eighths of its stroke. The piston rod passes through the top and bottom of the cylinder; its upper end is attached to a lever beam, which gives motion to a shaft for working the valve gear, and carrying a fly wheel of just sufficient weight to make the engine pass the centres without hesitation. The lower end of the piston rod is attached to the horizontal arm of a right angled bell crank, whose vertical arm is connected to the pump piston rod. The pumping apparatus is the same as that of No. 1, except the pump barrel, which is $19\frac{7}{8}$ inches diameter, or, one inch seven-sixteenths larger.

Both setts of pumping apparatus have upon their discharging pipes, an air vessel whose content is 230 cubic feet; there is also one upon the supply pipe, containing 30 cubic feet. In the absence of experiment, in this case, it cannot be determined whether the latter vessels are of use or not. The experiment of Messrs. Kirchweger & Prussman (*vide Journ. of Franklin Institute*, Third Series, vol. xxiv, p. 367,) show, that at high speeds of pump piston, the application of an air vessel to the supply pipe of a pump, is of positive benefit; but, in this case, the speed of the piston is not high, averaging 144 feet per minute; the supply pipe is more than one-half larger in diameter than the pump barrel; the pump is about eight feet below mean tide, which head is sufficient, after a liberal allowance has been made for friction in the pipe, to fill the vacuum made by the pump piston, when moving at a higher rate of speed than obtains in ordinary times. These advantages tend to show, that the air vessels on the supply pipes might be dispensed with, without prejudice, and, again, the coefficient of effect is not greater than where such an air vessel is not used.

In September, 1852, one of the reservoirs having been emptied, the Watering Committee instructed the engineer to fill it with pump and engine, No. 2, and keep an account of the time occupied in raising the surface of the water twelve feet above the bottom, when the content is, as previously stated, 4,642,026 gallons. The evaporation from such a large suface of water, and the absorption by the brick lining of the basin, would be probably compensated for by dews and rain; but, as no account of the weather was kept, extreme accuracy not being required, the amount of water raised may be considered as neither increased nor diminished by incidental causes. The time occupied in filling was, 60 hours; number of double strokes, marked by a register, 36,900.

This gives for each double stroke nearly 126 gallons. The space displacement of piston is nearly 178·5 gallons; the actual effect of the pump is, therefore, not quite 70·6 per cent. of its capacity, or about the usual per centage. No account was kept of the consumption of fuel, but, from the official report of the engineer, for the month of November, 1853, is taken the following account of the consumption of coal, running time,

number of revolutions, and amount of water pumped into the basin by No. 2.

Total tons of coal consumed, . .	120
Number of hours running time, including stoppages for oiling, cleaning, &c., 528, or	22 days.
Total revolutions, ...	389,919
Total gallons pumped into basin, estimating the quantity raised each double stroke at 126 gallons, as determined by the trial in September, 1852, ...	49,129,794

This gives as the actual effect realized by the expenditure of one pound of coal 182·77 standard gallons, or 1526 pounds of water raised 112 feet high, with a velocity of 164·5 feet per minute.

The evaporative efficiency of the boiler is about the same as in other boilers of its type, 'flue and rising return flue,' 8·75 pounds of water evaporated by one pound of coal. The feed water being supplied from the hot well of the engine.

When No. 2 performs the same work, with steam of ten pounds supplied by the cylinder boilers, there is required a consumption of eight tons of coal, which gives 5·98 pounds of water evaporated by one pound of coal: an increased effect which must be attributed to the slower and more perfect combustion of the fuel, as the fires need not be urged, but the contrary, when steam of but ten pounds is required.

Engine, No. 2, has been kept running at a speed of eighteen revolutions per minute, when the consumption of water from the basin has been so much greater than ordinary as to require it. At that speed the valves do not jar much more than when making twelve beats per minute, which is attributed to their construction, the part farthest from the hinge being made very heavy, to insure prompt closing before the return stroke of the pump piston permits the reflux of the water to close the valve with a blow; and, to the very large size of the air vessel on the ascending main, its content being thirty-four cubic feet (or nearly three times the capacity of the air pump barrel) of air, at a density due to the pressure resulting from the effort of the column of water in the main when moving at that velocity. The pressure, as determined by one of Bourdon's gauges attached to the main, per square inch of pump piston, when moving at different velocities, varies from the commencement of stroke to half stroke,

63 to 68	pounds	at a	speed of	120	feet	per	minute.
70 to 75	"	"	"	156	"	"	"
77 to 80	"	"	"	168	"	"	"

with 11 feet 3 inches of water in the basins. The speed of the water in main, being inversely as the diameters of the pump and main, will be 16¼ per cent. greater than the speed of that in the pump. When at the speed of 156 feet per minute, which is greater than that intended for ordinary service, the throttle valve was partially closed, effecting a reduction of, say 1·5 pounds below the boiler pressure of 10 pounds, making the initial cylinder pressure 8·5 pounds, which is farther reduced by expanding one-eighth, to a mean pressure of 8·4 pounds. Vacuum steam by gauge, 13 pounds, total pressure per square inch in cylinder=21·4 pounds.

The pressure per square inch on cylinder piston necessary to keep the pump piston at the above speed is $\frac{72{\cdot}5 \times 19{\cdot}4375^2}{42^2} = 15{\cdot}49$, subtracting this from 21·4 there remains 5·91 pounds, which is absorbed by the friction of the pump and engine and the load on the air pump.

The pressure per square inch on pump piston due to the head of water 120—8=112 feet is nearly 48·5 pounds: average pressure at 156 feet per minute 72·5 pounds; difference 24 pounds; equivalent to an additional head of nearly 55·5 feet, or almost one-half more than the actual height to which the water is raised. This proves that about one-third of the effective engine power is used in overcoming the friction and inertia of the water column. A loss that is occasioned by its devious course, two right angled bends, in addition to those of a small angle, caused by the inequalities of the ground through which the main is laid, at a uniform depth below the surface, occurring in the passage to the basins, and by its great length, over two and a half miles.

During the very warm weather of July last, one pump would not raise enough water to supply the increased demand, unless the speed of the engines was made greater than that considered prudent, and for which they were designed, twelve double strokes per minute.

To meet the demand, both engines were set to work, each averaging ten revolutions per minute, which speed was found adequate to keep up the supply.

Both pumps discharged into one ascending main of 18 inches diameter, which bore the increased pressure due to the increased velocity of the water, proving it to be of sufficient strength for the ordinary strain to which it is subjected.

For the Journal of the Franklin Institute.

Considerations Respecting the Hoosac Tunnel. By Edward W. Serrell, Civ. Eng.

The State of Massachusetts has granted a loan of $2,000,000, to the Troy and Greenfield Railroad Co. on certain conditions, to aid in the construction of the tunnel through the Hoosac Mountains; the connexion to be formed by means of this work between Boston and the West, is considered by its projectors and friends of very great importance, and by means of the State loan, recently obtained, it is proposed to re-commence operations on that part of the line, including the mountain section.

Irrespective of its importance in a commercial or financial point of view, let us consider it as an engineering enterprise.

The entire length of the tunnel is to be 24,100 feet, or 340 feet over four miles and a half. The summit of the mountain is about eight hundred feet above the grade line, and averages about six hundred feet over the tunnel.

The mountain is, according to Professor Hitchcock, primitive rock, of mica slate, nearly all the way through, with some lime and iron on the western slope.

The strata is nearly vertical, or inclined only from four to ten degrees.

The line of the direction of the railroad, crosses the strata nearly at right angles.

It is proposed to build the tunnel for a double track railroad.

In order that there may be a proper drainage, it is proposed to make a slightly ascending grade from either end to the centre.

To lay out this work and get it ready for the contractors, requires merely the careful use of properly adjusted, accurate instruments; but this is of itself, a task of no ordinary consequence.

The best plan to be adopted in constructing the work, is of more importance, and involves questions not ordinarily met with in railroad engineering.

Whether the tunnel shall be worked from both ends only, or whether shafts shall be employed, has yet to be determined. If shafts are used, then all the contingencies of pumping and hoisting have to be considered, and whether shafts are, or are not used, how to effect a proper ventilation, during the construction and permanently after the tunnel is built and is in use, is a question of the greatest consequence.

Then, too, it is no easy matter to determine what method shall be adopted to make the excavations after the plan is adopted on which they are to be made, whether by shafts or without them, and these questions of necessity run into and become one "of the *time* to be employed in doing the work."

Wilson's machinery, which was constructed before the loan was obtained from the State, and was tried at the easterly side of the mountain, is said to be defective in many particulars, but the inventor has modifications of his plans with which he confidently expects to be able to overcome all the difficulties. This machine is intended to cut a circular section, and leave a core in the middle, to be removed by wedges or blasting. Corcoran's machine cuts a circular tunnel, removing the whole face of the section; this machine acts by reciprocal movements; Wilson's by rotary motion.

Besides these, Gardner has invented a system of drills, which has merit in their combination. Browne, and others, have contrived various methods of applying ordinary drills, and still another plan is advocated, that of boring by the combustion of gases, and the application of electricity.

By some of these machines, or by something else not yet contrived, or by the old fashioned method of drilling by hand and blasting, the excavations have to be made.

The profession and the public will look with interest upon the plans adopted and the results arrived at.

---

*Railway Signals from China.**

Captain J. Norton described some methods of establishing communications between the guard of a railway train and the engine driver, one of which he exhibited that had been brought from China, and used there as a signal for different purposes. It consisted of a metal whistle fixed to a short stick, which when thrown through the air made a shrill sound.

* From the Civil Engineer and Architect's Journal, November, 1854.

The faster it is propelled, the louder the noise; and Captain Norton said the most effective way of using it for railway signals is to push the stick into the barrel of a pistol charged with gunpowder, and to fire it over the engine driver's head. In this manner he had, on several occasions, tried its efficacy, for when the train was going at full speed, he had sent the missile whistling through the air, and obtained an immediate response from the steam whistle, indicating that the engine-driver had heard it.

---

*Results of some recent Investigations of M. Vicat upon the Destructive Action which Sea Water exerts on the Silicates known in the Arts as Hydraulic Mortars, Cements, and Puozzolanas.**

M. Vicat, to whom we are so much indebted for our knowledge of the preparation of cements, has recently presented to the French Academy of Sciences, the following *résumé* of the chief general results to which a very long course of experiments upon that very important subject, the durability of cements in marine constructions, has led him:—

1. That the double hydrated silicates of lime and alumina, just mentioned, are very unstable compounds.

2. That pure water when poured upon all of them in the state of as fine powder as can be produced by ordinary means, no matter what might be their age or hardness, will dissolve a portion of their lime, provided they have not been in any way, or at least to a very slight degree, exposed to the action of carbonic acid.

3. That if, under the same circumstances, a very dilute solution of sulphate of magnesia or Epsom salt be substituted for the pure water, the greater part, and often the whole, of the lime existing as silicates passes into the condition of sulphate. If any carbonic acid had previously acted upon it, the carbonate of lime thus formed is not decomposed by the sulphate of magnesia.

4. That all puozzolanas, no matter what may be their ages, require for their complete saturation, a very much smaller quantity of lime than is added in practice, especially when we take into account their very imperfect state of division from the rough way in which they are usually prepared.

5. That the affinity of carbonic acid for the lime in combination in these various silicates is so strong, that it is possible, with the aid of a little moisture, to completely neutralize it, wherever it can penetrate, and thus leave all the other constituents of the cement, whether in combination or not among themselves, as mere mixtures in the mass.

It follows, from these results, that sea water will destroy every cement, mortar, or puozzolana, if it can penetrate into the mass immersed in it. As, however, certain of these compounds are perfectly durable when constantly immersed in sea water, they cannot have been penetrated by it. Its penetration has been prevented by the surfaces, and the source of this inability to penetrate, is chiefly caused by a superficial coating of carbonate of lime, which has formed either anteriorly or posteriorly to their immersion, and which in time augments in thickness. The effect

* From the London Artizan, August, 1854.

of a kind of cementation produced by the decomposition of the sulphate of magnesia, of the sea water, and the deposition of carbonate of magnesia in the superficial tissue of the mass, and the formation of incrustations and of submarine vegetation, contributes also to this impermeability. But all such superficial impermeable coatings, are not attached with the same force to the mass which they envelop. The differences which have been observed in this respect depend in some cases upon the chemical constitution, and upon the peculiar cohesion of the silicates, and in others upon their submarine situation, relative to the action upon the waves and the rolling or dashing of shingle upon them. Hence the differences which have been observed by engineers in the durability of concretes of which such silicates form the gange.

M. Vicat is preparing a memoir, in which he will attempt to explain the nature of the chemical constitution of those silicates which are durable, compared with those which are not; and which will show the preponderating influence of silica in such phenomena. He will also point out a simple and certain method of classifying all such compounds, as to their fitness or not for submarine constructions, and thus will assist in very much shortening the time necessary at present for testing them by exposure to the action of sea water. From the great practical importance of the subject, and the attention at present directed to it, this memoir will be looked forward to with considerable interest.

Comptes Rendus, January, 1854.

For the Journal of the Franklin Institute.

A new Method of Proportioning Stone Bridges. By JOHN C. TRAUTWINE, Civil Eng., Philadelphia.

I respectfully submit to the profession, the following method of determining the proportions of stone bridges. At the risk of being considered egotistic, I will venture to remark, that in my opinion, it possesses merit, not only *as a practical guide* to the unscientific mason; but also as being equally dependable with the results of any of the generally received theories.

It will be found to give proportionably thicker arches and abutments to small spans than to large ones. The necessity for this is well known to those of the profession who have studied the subject.

The method was devised by myself several years ago, while an assistant engineer, and before I had sufficient experience to warrant me in presenting it as a reliable contribution to engineering practice.

It applies alike to arches of any size or shape whatever, whether semicircular, segmental, elliptic, catenary, gothic, parabolic, &c., &c., as well as to every height of abutment.

The Rule is as follows: First, For the thickness, *a*, *b*, of the arch, or in other words, the depth of arch-stones in feet, take one-third the square-root of the span, *c*, *d*, in feet.

Next, draw the arch to a scale, with the thickness thus obtained; and add to it *c s*, and *d t*, the heights of the abutments; also, *s r*, and *t e*,

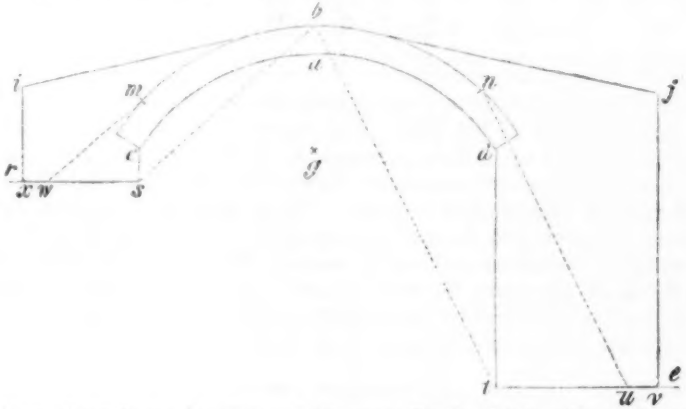
their base lines. Then, from the top of the arch, *b*, with an opening of the dividers equal to *one-half* the span *c d*, lay off *b m* and *b n*.

Next, draw *m w* parallel to *b s*; and *n u* parallel to *b t*.

Make *w x* and *u v*, each, equal to one-tenth part of the rise *a g*, added to one-tenth of the *half span c g*.

Then will *s x* and *t v* be the bases of the abutments, or of the abutment-piers, as the case may be.

Lastly, for the backs of the abutments, draw *x i* and *v j* to the height of *m* and *n*; and for the haunches, draw lines from *i* and *j* towards *b*, touching the arch as high as possible.



Above these lines the space will generally be filled with earth for the roadway; but if preferred, it may be carried up with solid masonry, or parallel walls.

A few of the lower courses of masonry should project so as to form feet for the abutments; and then, *the level of the top of the upper step or offset, should be assumed as the base line of the abutment* in drawing the figure, instead of the bottom of the foundation pit.

The rule remains the same in all particulars, for all arches whatever.

With first class materials and workmanship, *w x* and *u v* may be reduced slightly; but I regard the rule as it stands, better adapted to ordinary practice. Other trifling modifications suited to peculiar circumstances, will suggest themselves to an experienced engineer. The young practitioner will, however, bear in mind, that if his stone bridges are too slight, a few years of heavy railroad traffic will *shake them to pieces*, although they may stand very well for a while.

The arch of equilibrium for bridges, which forms the chief topic of discussion in theoretical treatises on that subject, has no existence in point of fact; and in small bridges, where a heavy load, as for instance a first class locomotive, bears a large proportion to the weight of the bridge itself, the principle utterly fails to be applicable. The smaller the bridge, the larger in proportion must be its parts; but to what extent we must proceed in adjusting them on this basis, depends upon the results of experience. I trust that my Rule will be found not to conflict with these; but to afford a really valuable aid to this important branch of engineering.

I subjoin a table of depths of arch-stones, calculated by this Rule.

Span of arch in Feet.	Depth of Arch-stones	Span of arch in Feet.	Depth of Arch-stones
	Ft. Ins.		Ft. Ins.
200	4 8½	60	2 7
180	4 5¾	50	2 4¼
160	4 2¾	40	2 1¼
140	3 11¼	30	1 10
120	3 7¾	25	1 8
100	3 4	20	1 6
90	3 2	15	1 3½
80	2 11¾	10	1 0½
70	2 9½	5	0 9

With these depths, there is no *necessity* for an increase as we approach the springing lines of the arch. The depth of the arch-stones does not depend altogether upon their resistance to the compressive action of the arch and its load, as writers assert. If this were true, they might be made much smaller than practice requires. They must have, in fact, such a depth as will secure to them a leverage sufficient to counteract the displacement attendant on striking the centers, filling in the haunches, &c., and the depth necessary for this purpose is so great, as also to warrant us, in practice, to overlook the modifying effect of the proportion existing between the rise and the span of the arch.

AMERICAN PATENTS.

List of American Patents which issued from Oct. 10th, to Nov. 7th, 1854, (inclusive,) with Exemplifications.

OCTOBER 10.

32. For an *Improvement in Railroad Car Seats;* Charles P. Bailey, Zanesville, Ohio.

Claim.—"I claim the so hinging together of the back, seat, and feet rests of a car seat, as that the back may be reversed, and the seat and feet rests swing both ways of a vertical line drawn through their centre, for the purpose of forming a self-adjusting seat, applicable alike to the car, whichever end may go foremost."

33. For an *Improvement in Machinery for Making Hat Bodies;* Leander W. Boynton, South Coventry, Connecticut.

"My improvement consists in the method of revolving and vibrating two hollow perforated cones, in connexion with an exhausting, picking, and blowing apparatus, and in so varying and governing the direction of the blast, that by putting the fur (in its ordinary state,) on to the feeding aprons, and setting the machine in motion, (by any convenient power) there will be formed two complete hat bodies ready for hardening, with the quantity of stock duly proportioned to the several parts."

Claim.—"I claim the method of using the cones by giving them a rotary and a vibratory motion, in such a manner as to bring every part of the outer surface of each cone into such a position that each part may receive its due proportion of stock to form a hat body, when constructed and made to operate as described. Also, the method of varying the direction of the apertures by the vibratory motion of the cones."

34. For a *Shingle Machine;* John A. Bradshaw, Lowell, Massachusetts.

Claim.—"I claim shaving shingles by causing them to pass between the faces of two

revolving rims, having volute threads cut thereon, and armed with suitable cutters or plane irons, and one of the said cutter rims being so hung as to be self-adapting to the varying thickness of the shingles."

35. For an *Improvement in Spinning Rope and Cordage;* J. Carpenter, City of N. Y.

Claim.—"I claim the elevation of the spool above the flyer shafts, so as to occupy the space between the flyer and the ball, whereby the heads of the flyer can be shortened, and a greater velocity obtained for the revolution of the flyer, thus increasing the speed of spinning by Whipple's process, and the regulation of the revolution of the spool by means of the friction wheel, whereby the yarn, whose draft and twist are governed by the capstan, is wound up as fast as it is delivered, with less tension, and with less liability to break."

36. For a *Rotary Pump;* Stephen D. Carpenter, Madison, Wisconsin.

Claim.—"I claim, 1st, A machine for pumping and forcing air, water, or other fluid, without the use of the ordinary valves used in pumps. 2d, Also, the peculiar arrangement of the air chamber, so as to avoid the trouble and expense of affixing a separate appendage for that purpose. 3d, Also, the peculiar arrangement of the air chamber, the application of the fan-shaped bar or 'propeller,' and the manner of constructing the outside shell, by which combination, when operated as described, to dispense with the use of the ordinary valves in pumps, lessen the expense, and enhance the durability and efficacy of the pump, and in these respects to render it more available for the use and purposes than any other pump in use."

37. For an *Improved Machine for Turning Hubs, Tool Handles, &c.;* S. Carpenter, Flushing, New York.

Claim.—"I claim, 1st, The use or employment of the pulley, constructed to communicate a continuous rotary motion to the stuff to be turned, and to allow the same to be fed freely through its axis at the proper intervals. 2d, The arrangement and combination of the pulleys, screw and worm wheels, levers and slide, for the purpose of operating the cutters and bit or auger. 3d, The arrangement of the belt shipper attached to the lever, and the arm attached to the upright, for the purpose of causing the turned articles to be cut off from the stuff of equal length."

38. For *Cutter Heads for Planing Machines, &c.;* John D. Dale, Philadelphia, Pa.

Claim.—"I claim the combination and arrangement of the screw hubs, inclosed in the concentric spaces formed in the heads, and capable of being turned by the hand or otherwise, racks or cogged bars acting as supports and guides to the heads."

39. For an *Improved Rock Drill;* Edwin G. Dunham, Portland, Connecticut.

Claim.—"I claim, 1st, so arranging a horizontal plate on the drill rod, that by bringing the lifter in contact with it, in the manner described, it will be caused to incline slightly during the raising of the drill bar, and consequently to bite or impinge upon said bar, and hold it firmly until it is raised to the position desired, and then, as the lifter escapes, again assume nearly a horizontal position, quit its hold, and fall with the drill. 2d, Rendering the friction plate for raising and dropping the drill bar, capable of removing said bar entirely out of the holes which are drilled, by employing, in connexion with it, the friction plate, which is set inclined, and made to hold the bar as it is gradually raised. 3d, The plate, when set inclining sufficiently to hold the drill while it is being raised out of the holes that are drilled, whether it be used in connexion with the friction plate or other arrangements in use for raising the drill bar. 4th, I claim increasing the friction of the plate upon the drill bar, and accelerating the descent and blow of the drill bar, by means of a spring arranged as described."

40. For an *Improvement in Magnetic Alarm Bells;* Augustus Eckert, Trenton, Ohio.

Claim.—"I claim combining with the train of mechanism that strikes the alarm, an endless screw, driving the toothed wheel, and one or more revolving levers, the said endless screw being fixed upon a sliding shaft that carries a brake wheel or disk, so that when the motion of the toothed wheel is arrested by the short arm or detent catching the levers, the sliding shaft will advance, carrying before it the spring until the motion of the train is stopped by the disk coming in contact with the brake pieces, and so that on the release of the levers, the force of the spring shall throw the levers off the detent, and release the disk from the brake pieces."

41. For *Improved Sewing Pin;* Thaddeus Fowler, Waterbury, Connecticut.

Claim.—"I claim the emery ball with the pin point fixed in its metallic rim, and provided with the hinged pin and hook, by which it is attached to the dress of the user, or to a table cloth."

42. For an *Improvement in the Construction of Sugar Making Apparatus;* Louis A. Gossin, Thibodeaux, Louisiana.

Claim.—"I claim, 1st, The arrangement of the boilers for generating steam, the pans for evaporating the juice, and the furnace, whereby a single furnace is made to supply the heat for both the generation of steam and the boiling of sugar, through the contact of the naked flame with the bottom of the pans. 2d, The combination of the skimmer, consisting of a series of scoops, inclined aprons, and conduits, with the evaporating pan. 3d, The combination with the discharge tube of the sugar syrup pan, of a jacket communicating at either side with and forming a part of the feed pipe of the steam boiler, whereby a stream of water is kept constantly flowing through the jacket to protect the syrup adhering to the sides of the pipe from being discolored by burning."

43. For an *Improvement in Railroad Chair Machinery;* Benjamin F. Gossin, Covington, Kentucky.

Claim.—"I claim, 1st, The combination of the semi-circular wheels, pillow blocks, rods, lever, and rod, for giving motion to the crank shafts, and throwing in and out of gear. 2d, The combination of the two crank shafts, the cutters attached to the said cranks, frame, and cutters attached to the said frame, all for the purpose of cutting the lips from the blank plate, and turning the same around the mandrel, and thereby forming the complete chair. 3d, The tapering of the two sets of cutters, 10 and 11, so as the cutters 10 will fall freely from the chair after being completed. 4th, The adjustable sliding piece to which the cutters, 11, are attached by means of bolts, or their mechanical equivalents, the piece is held to its place by the key, and is made so as to adjust the cutters to suit different thicknesses of iron, or to compensate for the wear of the cutters. 5th, The table on which the blank chair is laid between the two sets of cutters, the upper surface of said table extending up flush with the upper surface of the shaft cutters, and in this case attached to the framing of the machine at its upper part by means of bolts, or to any other part of the machine that may be desired, and substantially effect the purpose required."

44. For an *Improvement in Construction of Ships;* John W. Griffith, City of N. Y.

Claim.—"I claim the method of increasing the strength of ships by vertical plates of iron extending up vertically from the keelson to one or more decks, and secured to the keelson and deck, and extending the whole length of the ship. And I also claim giving additional strength to ships by means of longitudinal bulk heads of plate iron, and interposed between the centre keelson and the sides of the ship, and extending from the side timbers to the deck, and secured to them, whether made water tight or of open lattice work."

45. For an *Improvement in Brakes for Checking and Starting Cars;* Robert Grant City of New York.

Claim.—"I claim the application and employment of a spring, spiral or other similar convenient form, of metal or other suitable material, in combination with the axle or wheel, or other running gear of railroad cars or other vehicles, for the purpose of stopping and starting, or either, a car or vehicle. Also, the apparatus for winding up or compressing said spring, and causing it to act upon the axle or wheel by means of the fast and revolving clutches, with their connexions and escapements. Also, the employment and application of sectional tubes or washers on the axle or shaft, when used in the said combination, for the purpose of preventing the spring from binding, and to enable the same to be easily and fully compressed."

46. For an *Improvement in Compounds for Neutralizing Chlorine;* Eben N. Horsford, Cambridge, Massachusetts; patented in England, May 9, 1854.

Claim.—"I claim the process of neutralizing chlorine by means of the substance called anti-chloride of lime."

47. For an *Improvement in Pawl Drills;* Simon Ingersoll, City of New York.

Claim.—"I claim the centre piece constructed with two gudgeons or pivots, or their

equivalents, for the wheels to turn upon, and to form or support the fulcra of the lever by which the drill is operated, thereby enabling the operator to vibrate the lever in the same plane with the shaft and drill, or in a plane at right angles to it, as may be most convenient."

48. For an *Improved Saw Gummer;* John Jack, Fayetteville, Ohio.

Claim.—"I claim the arrangement of the parts of the machine, in combination with a short die lever, bearing a friction roller, and another hand lever to manœuvre an eccentric working on said friction roller, as a means of working a hand machine for gumming saws, whereby said machine is rendered more compact, portable, economical, and efficient than any at present known or used."

49. For an *Improvement in Cans for Holding Liquids;* L. Jennings, Erving, Mass.

Claim.—"I claim the wooden can having its upper head convex, and being furnished with a handle, as described."

50. For an *Improvement in Looms;* Stephen C. Mendenhall, Richmond, Indiana.

Claim.—"I claim opening the shed by a pattern wheel so arranged that while its rotary motion commences the opening of the shed, it shall have a vertically yielding motion to and with the treadles, when combined with a wedge-shaped bar on the lay, arranged to separate the treadles, and thus complete the opening of the shed, both the pattern wheel and wedge-shaped bar being moved by the lay."

51. For a *Shingle Machine;* Elijah Morgan, Morgantown, Virginia.

Claim.—"I claim the providing of the head block with an oblong straight slot, a zigzag slot, and a fulcrum, and combining the same with an arrangement of mechanism similar to that herein specified, or its equivalent. I also claim the arrangement for holding the log."

52. For an *Improvement in Fastenings for Garments;* Richard Oliver, City of N. Y.

Claim.—"I claim, in buttons or fastenings for clothes, having one end of their eyes hinged or rigidly fastened to the button, making the eye elastic, in combination with the cavity or counter-sink, to facilitate the inserting of the other end of the eye into the hole, or its equivalent, into which it is hooked in closing the eye to fasten the button."

53. For an *Improvement in Machines for Splitting Horn, &c.;* Emerson Prescott, Leominster, Massachusetts.

Claim.—"I claim a single platen press of power sufficient, when the shell or horn is softened or rendered expansive by heat, to reduce it to a uniform thickness on the carriage, and to preserve it in such state preparatory to and while it may be moved against the splitting knife."

54. For an *Improved Damper for Ovens;* John P. Sherwood, Fort Edward, N. Y.

Claim.—"I claim the arrangement of the revolving damper, whereby the heat of the oven can be tempered and regulated."

55. For an *Improvement in Ginning and Cleaning Cotton;* C. Speer, City of N. Y.

Claim.—"I claim the combination of an endless belt or chain with the roller beater, the said roller beater being placed so as to work directly upon the flat or closed portion of such belt or chain, while its closed teeth holds the fibre, thus performing the whole separating process without the intervention of any other machinery, other than that of feeding and clearing the machine."

56. For an *Improvement in Steam Engines;* Henry Tongue, Nashville, Tenn.

Claim.—"I claim constructing the piston of a semi-rotary engine with sliding metallic packings, in combination with the stop and cylinder."

57. For a *Polishing Machine;* Henry Volkening, City of New York.

Claim.—"I claim the application of an elastic substance, as cushion, between the polishing material and the body to which the same is attached."

58. For an *Improvement in Turning Lathes;* Albin Warth, City of New York.

Claim.—"I claim the guide levers, or their equivalents, in combination with the spring slides, or their equivalents, and the guide plates or their equivalents."

59. For an *Improved Locomotive Lamp;* Irvin A. Williams, Utica, New York.

Claim.—"I claim, 1st, Constructing the can with partitions for preventing the swash of the fluid, and insuring a steady feed to the burner. 2d, The combination of the perforated inverted cone, cap, funnel, and perforated tube, for admitting air to the can, and preventing the slopping of oil from the vent."

60. For an *Improvement in Smut Machines;* Thos. B. Woodward, Philadelphia, Pa.

Claim.—"I claim covering the apertures by which the air is discharged from the fan case into the side pipes with grates, to temper and diffuse the blast, prevent the grain from getting into the fan case and being broken by the fans and retarding the machine by the friction it produces."

61. For an *Improvement in the Construction of Sugar Boilers;* Edward J. Woolsey, Astorio, New York.

Claim.—"I claim an apparatus consisting of a centrifugal distributor, arranged within a heated pan, or otherwise arranged relatively to heated surfaces, which are equivalent to the heated interior surface of the pan, or of the coils contained therein, so as to throw the juice, syrup, or solution to be evaporated, in a shower, or minutely subdivided state, on the said heated surfaces, and allow it to trickle down the sides of the pan or the said heated surfaces in a thinly diffused state, for the purpose of evaporating its moisture."

62. For an *Improvement in Processes for the Manufacture of Salt;* Samuel B. Howd, Assignor to Thomas F. Davis, James F. Leach, and R. F. Stevens, Syracuse, N.Y.

Claim.—"I claim, 1st, Mixing weak with strong brine in the steam chamber of the boiler, and passing the brine thus mixed into a settling apartment or chamber connected with the lower part of the boiler, and thereby causing the separation and deposite of impurities from the brine before it comes into contact with the fire surface of the boiler. 2d, The method of purifying brine, viz: by evaporating it in closed boilers to such an extent as to cause the separation and deposit of its impurities while under pressure of steam, in combination with vats for crystallizing the salt from the brine thus purified."

OCTOBER 17.

63. For an *Improvement in Looms for Weaving Cut Pile Fabrics;* Erastus B. Bigelow, Boston, Massachusetts.

Claim.—"I claim, 1st, The method of adapting the cutting knife to the proper position relative to the wire to be cut out under the varying conditions of the loom, by making the frame or carriage which supports or carries the said cutting knife movable. Also, in connexion with said movable frame or carriage which supports or carries the cutting knife, a guide or guides to rest against the wire to be cut out, to preserve said frame or carriage and cutting knife in a proper position relative to said wire. Also, connecting the cutting knife with the reciprocating bar, by means of a double acting or compound joint. Also, in combination with the reciprocating bar, or its equivalent, with which the cutting knife is connected, the employment of a guide which shall move in unison with said cutting knife to insure its proper position relative to the wire to be cut out. And, finally, I claim the method of preventing the wires from being drawn down on their sides, by means of hooks or bars."

64. For an *Improvement in Power Looms;* Joseph T. Barnes, Manayunk, Penna.

Claim.—"I claim, 1st, Fitting the journal boxes of the crank shaft to slide on ways on the framing, upon which, when liberated by reason of some obstruction in front of the reed, they are capable of being drawn back to carry back the crank shaft from its operative position, and prevent the further advance of the lay, by springs, or their equivalents. 2d, Setting free the journal boxes of the crank shaft from the hooks, or their equivalents, which hold them in proper operative position, by means of a rock shaft or roller hung in bearings, in rear of the breast beam, or otherwise conveniently placed near the front of the loom, said shaft or roller having attached to it a bar, which is conveniently placed for the breast beam to pass under it, and for the shuttle, when the latter is arrested in front of the reed, to be driven against it and drive it forward, and thereby throw up two arms which are also attached to the shaft or roller, and cause the latter arms to set free the journal boxes of the crank shaft, and allow them to retreat and carry

back the shaft. 3d, Furnishing the crank shaft with cams, which, when the loom is started with the shaft thrown back, work in contact with fixed pins or projections on the loom framing, and throw the shaft and its journal boxes forward to their operative position."

65. For an *Improvement in Machinery for Trimming Hat Bodies;* Daniel Barnum, City of New York.

Claim.—"I claim, in combination with the pick or brush, and perforated cone or former, the employment of currents of air at the bottom and sides to guide and direct the deposit of fur on to the cone or former. Also, the employment of a form made of grass cloth, or other flexible material pervious to air, on which to deposit the fibres in forming the bat, and to be taken from the perforated metallic cone or former with the bat, and retained inside as an 'inlayer,' during the after process of hardening. And, finally, I claim the employment of an india rubber cap, to be put on to the bat of fur to hold the fibres together in taking off the bat from the perforated cone or former, and to facilitate the hardening of the bat in the dry state."

66. For *Water Metres;* Joseph D. Elliot, Leicester, Massachusetts.

Claim.—"I claim the combination of the measuring chambers or reservoirs with the cock, that is to say, so that a measured quantity of water shall be let in and drawn off at each and every turning of the cock. Also, in combination with the cock and reservoirs, the register made as described. Also, in combination with the reservoirs, the air passage with its float, or equivalent valves, for the purpose of forming a governor to receive and discharge the water under the same head."

67. For a *Smoke Consuming Stove;* E. A. Hill, Joilet, Illinois.

Claim.—"I claim, 1st, The combination and arrangement of the smoke passage, damper, and draft flues, for the purpose of conducting the unconsumed smoke or carbonic oxide through completely ignited coals, in a simpler and readier manner than has been done before. 2d, The combination of the draft flues with the pipe, for the purpose of supplying the stove with the necessary quantity of air to insure the complete combustion of the fuel, or for preventing the smoke smothering the fire."

68. For an *Improvement in Shoemakers' Edge Planes;* D. W. Horton, Petersburgh, Indiana.

Claim.—"I claim the combination of the guard with the head and the blade, in such a manner as to form a sole and heel edge plane that is adapted to the use of the right or left hand."

69. For *Iron Buildings;* Bernard J. La Mothe, City of New York.

Claim.—"I claim, 1st, The construction of the frame or skeleton of buildings with bands or plates of iron or steel, or other metal, riveted or secured together in sets of several parallel bands, the same extending from the foundation to the top of the structure in lieu of columns, pillars, or walls. 2d, The making of the beams for the floors, and the rafters for the roof, by bending a certain number of the parallel bands which have been used in the perpendicular walls below, to the required position to serve as beams and rafters, the same being strongly riveted or screwed together. 3d, The vertical continuous beam, constructed of several parallel plates strongly riveted together, and also the combination of the horizontal and vertical beam of parallel plates."

70. For an *Improvement in Grain and Grass Harvesters;* John H. Manny, Freeport, Illinois; ante-dated June 15th, 1854.

Claim.—"I claim the arrangement of the platform obliquely to the cutter, so that the gavels of cut grain will be discharged at a sufficient distance from the standing grain to leave a clear pathway between the two for the team to travel in. Also, the combination with the platform of a wing, to facilitate the gathering of the grain. Also, making the outside dividing finger hollow, so that while it affords sufficient room for the play of the end of the sickle, the bearing of the latter thereon will not be so wide as to afford a lodgment of gum, grass, &c., and render it liable to be clogged thereby."

71. For an *Improved Grinding Surface in Mills;* Charles Ross, Rochester, New York.

Claim.—"I claim the forming of a grinding surface in mills, by lining a cast iron concave with radial segments, of burr or other stone, said segments being fitted and secured to their places."

72. For an *Improvement in Roving Tubes;* Moses Sargent, Jr., Meredith, N. Hamp.

Claim.—"I claim combining with the common trumpet-mouthed roving tube, one or more hooks, so as at all times to secure the condensing of the roving while unbroken, and permit a broken roving to be pierced without stopping the machine, or even a single tube."

73. For a *Sawing Machine;* John J. Squire, St. Louis, Missouri.

Claim.—"I claim, 1st, The employment or use of the radius guide, arranged and applied to the saw for the purpose of controlling the same, and preventing any tremor thereof. 2d, Placing the feed rollers in a movable or sliding frame, for the purpose of gauging the stuff to be sawed, and properly presenting said stuff to the saw, and guiding it while being sawed."

74. For an *Improvement in Water Pipes;* Richard B. Stevenson, York, Ohio.

Claim.—"I claim the combination of pipe of sheet zinc, or other suitably cheap and durable sheet metal, and an exterior coating of said hydraulic cement mortar of requisite thickness for strength, durability, and impermeability, for conveying water or other fluids beyond the action of frost, from one point to another."

75. For an *Improvement in Processes for Enameling Iron;* Conrad F. Thornin and Charles Stumer, Cincinnati, Ohio.

Claim.—"We claim treating the cleansed surface of the sheet or wrought metal to be enameled with a mucilage or viscid solution, and powdering or otherwise evenly distributing the pulverized frit thereon."

76. For an *Improved Joint for Toilet Glass;* Henry Wayne, Cincinnati, Ohio.

Claim.—"I claim the vibrating bracket, having a segmental wing with tapered indentations and spring pawl, or their equivalents, in combination with the horizontally rotating pivot, as described, forming a shifting joint for a toilet glass."

77. For an *Improvement in Brick Presses;* E. D. Williams, Wilmington, Delaware, and T. Tyrrell, York, Pennsylvania.

Claim.—"We claim, 1st, The employment, placed between the mechanism which produces the first, and that which produces the final pressure, of a perforating apparatus, consisting of a number of pins which are protruded through the bottom of a box, or its equivalent, and which is otherwise arranged, to perforate or prick the partly pressed clay to allow of the escape of air which may be contained therein before the final pressure. 2d, The particular method of giving the said movement by means of the loose collar fitting to the shaft, and having prominences and depressions corresponding to similar depressions and prominences on a fixed collar, and having projections on its side to come in contact with spring dogs attached to the framing."

78. For an *Iron Bridge;* John Yandell and Joseph H. Johnson, St. Louis, Missouri.

Claim.—"We claim the peculiar mode of connecting together of all the several parts as they are employed in the tension tress work, and also as the mode of combining the same with suspension cables."

79. For an *Improvement in Vessels for Holding Liquids;* James H. Stimpson, Ex'r. of James Stimpson, dec'd., late of Baltimore, Maryland.

Claim.—"I claim the double wall pitcher, the same consisting in a pitcher with double sides, double bottom, and a hinged cover, from which the liquid contents are to be poured through or over a nose or lip. Also, the employment of a chain or string attached to the handle and lid of the pitcher."

80. For an *Improved Pen and Pencil Case;* John Richardson, City of New York.

Claim.—"I claim the operating sleeve, having a turning as well as a sliding movement, in combination with the pen and pencil holders, and the interior mechanism."

OCTOBER 24.

81. For an *Improvement in Ploughs;* Henry F. Baker, Centreville, Indiana.

Claim.—"I claim providing the share, which forms part of the mould board, with a curved slotted arm, and attaching the slotted curved end to the arm, and its forward end to the point, and combining the same with the curved slotted arm and adjusting lever.

through the vibrating rod, in such a manner that the ploughman can, while behind the plough, adjust the mould board in the arc of a circle, with greater convenience and facility than heretofore."

82. For an *Improvement in Sifting and Bolting;* M. S. Bassett, Wilmington, Del.

Claim.—"I claim the riddle, as described, in connexion with a shaft and bearings, centralizing said riddle so as to rotate against an ordinary flat sieve disk at its margin, as a feeder, distributor, and vibrator."

83. For an *Improvement in Smut Machines;* John D. Bedwell, Uhricksville, Ohio.

Claim.—"I claim the rotating inner and stationary outer cylinders, both constructed of overlapping metal bars, when combined and arranged with an outer close cylinder, and operating in connexion with a fan blast or suction made to communicate with the interior of the rotating bar cylinder, as well as with the inclosed space surrounding the outer stationary bar cylinder, and with the trunk."

84. For an *Improvement in Straw and Grain Separators;* Archibald Bowen, Wadesville, Virginia.

Claim.—"I claim the method of separating grain and chaff from the straw, by the combination of the inclined vibrating bed with the perforated jointed bed, so that the grain and chaff are separated from the straw, and the straw conveyed over the foot of the machine by the bed, B, while the bed, E, conveys the grain and chaff in the opposite direction, and submits the same to the action of the fan blast for further separation. Also, the extending of the upper screen by the double inclined plane, in combination with a blast compressed by a covering above the screen, for the purpose that an eddy may be formed by the blast, and the grain, if carried too far by the blast, be returned upon the inclined plane to the screen."

85. For an *Improvement in Machinery for Softening Hemp and Flax;* Robt. Boyack, Poughkeepsie, New York.

Claim.—"I claim softening flax, hemp, &c., by means of a reciprocating plate having a slot through it, and working between two pairs of fluted rollers, the flax or hemp passing between the two pairs of rollers, and through the slot in the plate, and operated upon by the plate and rollers."

86. For an *Improvement in Machinery for Cleaning Cotton;* Samuel W. Brown, Lowell, Massachusetts.

Claim.—"I claim making racks or grids to be used in cotton and other pickers, of a number of bars of iron, or other substance, each of these bars being beveled to an edge, and these edges so arranged and placed in the rack that the cotton or other substance will first come in contact with the edges of the bars as it is thrown forward over them by the beater. The bars of these racks being tied or held together once in about three inches, more or less, by cross-ties, they being cast with the bars of the racks, or otherwise firmly connected to the bars for the purpose of staying them, and always presenting parallel slots of equal width for the dirt to pass through."

87. For an *Improvement in Chairs for Round Rails;* P. S. Devlan, Reading, Penna.

Claim.—"I claim the method of confining cylindrical rails at their joints by a chair which forms the rail between the joints, and so made as to keep and support the rails in proper line, whilst they may at the same time be turned in their bearings in said chairs, as well as the intermediate ones."

88. For an *Improvement in Mill Bushes;* George L. Dulany, Long Meadow, Va.

Claim.—"I claim the use of springs actuating the nuts on draw bolts."

89. For an *Improvement in Seed Planters;* Absalom B. Earle, Franklin, N. York.

Claim.—"I claim constructing the drag bar and drill tube, and connecting them. 2d, The spring guard plate fitted in each delivery opening between the hopper and the slide, to prevent the fracture or bruising of the seed, when the slide is drawn suddenly back."

90. For an *Improvement in Granaries;* Ebenezer Ford, Spring Cottage, Mississippi.

Claim.—"I claim the mode of making granaries, having the walls, floors, and partitions filled in with common salt."

91. For an *Improvement in Gutta Percha Stereotype Compositions;* Julius Herrick, City of New York.

Claim.—"I claim making moulds and plates for printing characters or figures of gutta percha or india rubber, compounded with some other substance or substances, which shall give to the compound the required hardness and stiffness, and not destroy its plasticity when in a heated state."

92. For an *Improvement in Bran Dusters;* Joseph Johnston, Wilmington, Delaware; ante-dated April 24th, 1854.

Claim.—"I claim constructing the frames of the concaves or cylinders which support the wire cloth in bran dusters of cast metal, so as to secure the objects and advantages specified."

93. For an *Improvement in Looms;* Barton H. Jenks, Philadelphia, Pennsylvania.

Claim.—"I claim, 1st, The single spiral cam, in combination with the shifting clutch and lever for raising and lowering, alternately, a two shelf shuttle box, or holding the same stationary for a longer or shorter period. 2d, The method of rendering the pattern or pin wheel capable of working larger patterns than it could heretofore work without increasing its size, by means of a multiplier, whether the same be constructed, arranged, and connected with the wheel, or otherwise, provided the wheel has its capacity increased. 3d, One shuttle binder, whether placed in the front or back of the lay, in combination with a series of shuttle boxes, in such manner that the binder will perform the ordinary duties of that instrument for every shuttle box of a series however numerous. 4th, Arranging and operating the shuttle binder independent of the shuttle boxes, in such manner that it shall be withdrawn from the shelves at the proper time to allow the boxes to be moved without obstruction from it. 5th, The method for clearing the shuttle from the picker, preparatory to raising or lowering the shuttle boxes, by moving the shuttle from the outer end of the box a short distance by a slight forward movement of the picker, or holding the picker slightly in advance of its extreme back position, until the shuttle is in place, and then allowing it to retreat back from the end of the shuttle, whereby the picking mechanism detaches itself from the shuttle before the shuttle box moves, instead of making this clearance dependent upon the motion of the lay, or other parts of the loom, as heretofore. Lastly, The construction of the shifting cam for working the treadles with its two screw tread and nuts of unequal pitch formed on separate sections of the cam, the sections which contain the thread of longest pitch being removable, so that a corresponding piece with a thread of different pitch may be substituted to adapt the cam to operating a variable number of treadles, and likewise to facilitate repairs."

94. For an *Improvement in Manufacturing Carpets and Rugs;* John G. McNair, West Farms, New York.

Claim.—"I claim a new fabric which I denominate tapestry chenille, consisting of tapestry chenille weft woven with the colors to produce the designs in sections, but without the ground color of the intended design, which prepared chenille weft is afterwards woven into and combined with a Brussels, ingrain, or other web, which is to constitute the ground of the design."

95. For an *Improvement in Fire Arms;* Gustav Friederick Palmié and Anton Herrmann Palmié, Berlin, Prussia.

Claim.—"We claim, 1st, The formation of a cushioned valve seat upon the end of the needle bar, to close the opening through which the needle passes into the charge, and also to prevent concussions of the main spring. 2d, The safety locking bolt, being an independent positive stop to hold the main spring and prevent the discharge of the gun when desired."

96. For an *Improved Pen Holder;* Myer Phineos, City of New York.

Claim.—"I claim the use or employment of a spring reacting in both a longitudinal and transverse direction, in combination with a cylindrical pen holder."

97. For an *Improvement in Machinery for Polishing Paper;* Edward L. Perkins, Roxbury, Massachusetts.

Claim.—"I claim the combination of the pressing roll, a bed plate (over which the roll runs back and forth,) to support the paper beneath the roll and feeding rolls, or the

equivalent thereof, arranged to feed the paper across the bed plate with an intermittent motion, which alternates with the passage of the pressing roll along the bed plate."

98. For an *Improvement in Making Wrought Iron Direct from the Ore;* James Renton, Cleveland, Ohio.

Claim.—"I claim combining with the combined deoxidizing apparatus and puddling furnace, the employment of a blast or blasts to be forced on the deoxidized ore on the hearth or hearths, to aid in decarbonizing the ore and increasing the heat."

99. For an *Improved Sliding Pen and Pencil Case;* John H. Rauch, City of N. York.

Claim.—"I claim the employment of the cylindrical turning slide, having a T-shaped slot cut in its upper end, and a spur secured in one of its lips, in combination with the slotted pen and pencil tube, and pins of the pen and pencil, when said tube is provided with three longitudinal slots and a transverse groove, or their equivalents."

100. For an *Improvement in Pen and Pencil Cases;* John Richardson, City of N. Y.

Claim.—"I claim the combination of the adjusting pin with the pen and pencil holders, and the sliding ferrule for moving them in and out. Also, the parallel slots in the frame, in combination with the adjusting pin, whereby the holder may be increased and diminished in length by extending and contracting its upper end."

101. For an *Improvement in the Square, Scale, Level, and Bevel;* Josiah Shanklin, Parkersburgh, Virginia.

Claim.—"I claim the combination of the blades with the grooves and thumb screws, in such manner that my instrument can be used for the purpose of a square, bevel, level, and scale."

102. For an *Improvement in Safes;* Benjamin Sherwood, City of New York.

Claim.—"I claim the combination of clay with about an equal quantity of alum of commerce, or any other salt that will dry heat, to form a fire-resisting and fire-annihilating compound. I also claim placing in the safe next the outer walls, a thin fire-brick or tile, to protect the composition from the contact of fire, when the iron shall have burnt through."

103. For an *Improvement for Fastening Lamps to Lanterns;* E. Sirret, Buffalo, N. Y.

Claim.—"I claim fastening the lamp to the bottom of a lantern, by means of a vibrating spring lever carrying a bolt pivoted near each end of it, said bolts passing through the bottom of the oil cup to enter a groove or flanch inside the bottom of the lantern."

104. For an *Improvement in Stoves;* Oron W. Wade, Versailles, New York.

Claim.—"I claim a stove, the sides of which are doubled, and made, one of them, of transparent or translucent material, and the other of an opaque substance, one or both of which may be removed or replaced at pleasure."

105. For an *Improvement in Mills;* William Warwick, Birmingham, Penna.

Claim.—"I claim the mode of regulating the cut of grinding mills by the insertion of a traveling wheel or anti-friction roller, in combination with the beveled track on which the roller travels. Also, the position of the thumb screw, it being parallel with the handle, and not as in other mills, perpendicular with the cutting burr and shell. Also, its use as a journal for the traveling roller."

106. For an *Improvement in Rotary Steam Engines;* B. H. Wright, Rome, N. York.

Claim.—"I claim, 1st, Whenever a central piston wheel is used, the double cylinder, the one sliding on the other. 2d, The two parts separately, and in combination, viz: the method of inserting a single piece of packing in the inner surface of the piston through an aperture or recess in the latter, with a corresponding but limited cut in the piston wheel, together with the mode of protecting this aperture by the lateral overlap of the base or flanches of the piston. 3d, The double oscillating valve, having opposite wings, nevertheless preserving the advantage of a single wing through the peculiar outline or use of a lesser cylindric surface between the wings on the side of the piston channel, reducing the cut in the cylinder for the passage of the piston to the least practical dimensions. 4th, The introduction, in connexion with a like cylindric surface, between the two wings on the opposite side of the valve, of a partition and separate chamber adjacent to the outer wing, for the purposes explained. 5th, The arrangement, in connexion with the oscillating valve of the induction and eduction passages, such that the

first open just at the termination of the revolution of the valve athwart the piston channel, and the second by an aperture in the valve cap, uncovered by the opposite wing when the valve is in the position before stated, the purpose of the arrangement being to promote regularity of movement, and the working of steam expansively. Also, the method of compensating for the less ready action of steam directly on the piston by the use of tappets, which are forced by the revolution of the valve down the abrupt inclination of an exterior cam wheel. 6th, Separately, the passage through the valve, commencing near its periphery and terminating at the plane surface or valve seat, as described, and as a combination for bringing the valve down across the piston channel. I claim the combined action, first, of the entering steam on its adjacent end of the valve; second, of the steam passing through the valve entering its induction wing from the piston channel, and discharging from the eduction wing against the valve seat; and, third, taking away, to any desirable extent, the resistance in the separate chamber behind the eduction wing. 7th, The method of balancing the pressure on the cylindrical cut-off valve, that is to say, by the removal of a suitable extent of surface diametrically opposite to the passages, or where there are two passages proximately situated, it is obvious a middle point may be used. These cuts or openings not being designed for steam passages, it is evident that their size or dimensions will be governed by totally distinct considerations. 8th, Governing the velocity of the engine by changing the position of the eccentric disk, which governs the motion of the cut-off valves, by the lever from the governor, said disks when thus changing having a transverse motion on the shaft. 9th, The annular steam chamber formed in one of the heads opposite to the piston channel, with branches to the cut-off cylinders respectively; and a like chamber in the other head as a common receiving chamber for the eduction ports."

107. For an *Improved Air Heating Furnace;* Walter Bryant, Assignor to John B. Kelsey, Boston, Massachusetts.

Claim.—"I claim the improvement in the construction of the radiator, arranged over the dome of the fire pot, the same consisting in making its bottom a concavo-convex plate or arch, and with the concave side disposed downwards and directly over the said dome, whereby the ascending heat from the top of the dome is retained in the concavity of said bottom, and not only made to warm to greater advantage the air that rushes into the same, but to heat the radiator so as to improve the draft through the fire pot and supporting columns of the radiator."

108. For an *Improvement in Bearings for Loose Pulleys;* William Campbell, Assignor to self and E. W. Shippen, Philadelphia, Pennsylvania.

Claim.—"I claim a loose or suspension pulley, or pulleys and hanger, having an axis, whereby a loose pulley may revolve independently of the shaft."

109. For an *Improvement in Securing Lamps and Lanterns;* Wm. Porter, Williamsburgh, N. York, Assignor to Joseph N. Howe, Boston, Massachusetts.

"My invention consists in placing the springs which hold the two together entirely beneath the base of the lamp, and in combination therewith, in surrounding the lamp with a flanch or cup, which shall effectually prevent any oil which may escape from the lamp from dropping upon either dress or furniture."

Claim.—"I claim as my invention, the lantern, as above described."

110. For an *Improvement in Roller Catch in Self-Acting Mules;* Mark R. Pearson, Georgetown, Assignor to self and Samuel Shaw, Wareham, Massachusetts.

Claim.—"I claim combining with the catch and the ratchet, the arm and its friction brake, or the equivalent therefor."

OCTOBER 31.

111. For an *Improvement in Steam Engines;* Nathan Atherton, Philadelphia, Pa.

Claim.—"I claim a cylinder with inclined projections for operating the valve gear by motion taken directly from the cylinder, whereby the proper lead may be given to the steam, whether the cylinder be turning to the right or left, and the engine is rendered more convenient, compact, and durable, than any heretofore known in which the axis of the driving shaft is parallel to that of the piston."

112. For an *Improved Key for Tuning Piano Fortes;* A. Bassford, City of N. York.

Claim.—"I claim combining the socket spindle with the handle spindle, by the inter-

position of cog gearing, or the equivalent thereof, to increase the leverage of the handle spindle relatively to the socket spindle, and have the axis of the two in or nearly in the same line. And, also, in combination with the two spindles combined together with interposed gearing, the employment of an arm or lever rest projecting from the plate of the interposed gearing to form a rest."

113. For an *Improved Press for Printing in Colors;* A. M. and G. H. Babcock, Westerly, Rhode Island.

Claim.—"We claim, 1st, The arrangement and combination of the polygonal platen and beds. Also, the construction and arrangement of the inking rollers, consisting of the vibrating arms and springs for holding out the rollers in place. Also, the combination of arms, or their equivalents, for giving a series of impressions forming progressive levers. Also, the apparatus for turning the prism, consisting of the vibrating arm, disk, springs, and pins, or their mechanical equivalents, with the apparatus for engaging and disengaging the same. Also, the arrangement and combination of the friskets with the platens, and the springs attached thereto, for giving a firm hold while drawing the sheet from the type."

114. For a *Knife Die for Cutting Leather Straps for Whips;* C. Baeder, City of N. Y.

Claim.—"I claim the use of the spiral knife die to cut gradually tapering strips of leather, for the manufacture of raw hide and braided whips."

115. For an *Improvement in Grain Winnowers;* Joseph Barker, Honesdale, Penna.

Claim.—"I claim the combination of the conical hopper, circular screens, with inclined sides, or of conical form and fan."

116. For an *Improved Burglar's Alarm;* Ephraim Brown, Lowell, Massachusetts.

Claim.—"I claim the making of the knob of the drawer movable, and so combining it with an alarm apparatus as to cause an alarm to be sounded whenever an attempt to open the drawer by pulling on the knob is attempted. Also, the combination of the latch or spring bolt, and the secondary bolt and key or lever, with the movable knob and the drawer. Also, the combining of the alarm pawl with the knob rod by means of a movable hanging lever, to be operated or moved by a stud, or its equivalent, fixed to the knob rod. Also, the decoy key and its connexions with the hanging lever, so as to operate as specified. Also, the connecting the said hanging lever to the secondary lever, so that a forward pull on the secondary lever shall move the hanging lever, so as to effect the sounding of the alarm. Also, the combination of the counter or numbered wheel, and its operative mechanism, with the knob rod, the same being to exhibit the number of attempts at opening the drawer, meaning also to claim the so combining the operative mechanism of the counter wheel with the hanging lever, that a movement of the latter will effect a movement of the said wheel."

117. For an *Improvement in Apparatus for Tempering and Flattening Saws;* Wm. Clemson, Boston, Massachusetts.

Claim.—"I claim making those ends of the plate which the saw enters, with their faces of beveled or other receding form, whereby they are enabled to impart heat to the saws by radiation before they enter, and thus cause every part of the saw to be heated to a proper degree before being submitted to the pressure of the upper plate."

118. For a *Shingle Machine;* Harry H. Evarts, Assignor to self and A. J. Brown, Chicago, Illinois.

Claim.—"I claim placing the blocks to be sawed into shingles in a rotating carriage, which is combined with inclined tables, or a single table, and with saws, or a single saw, in such a manner that the blocks will be carried continuously forward, and be automatically operated upon, to convert them into shingles. Also, the arrangement of the weighted levers, the fastening teeth, and the inclined planes with each other, and with the inclined tables and the outer series of teeth in the ledger. Also, presenting the sides of the fibres of the wood to the action of the saws in the sawing of shingles, or equivalent articles, for the purpose of giving them smoother surfaces than can be produced by the usual mode of sawing."

119. For an *Improved Burglar's Alarm;* Junius Foster, Green Point, New York.

Claim.—"I claim the spring barrel with the zig-zag groove around its circumference, in combination with the lever, bell, and stop, or its equivalent."

120. For *Machines for Filling Match Frames;* Wm. Gates, Jr., Frankfort, N. York.

Claim.—"I claim the feeding bar, with its projections, pressure rods, and gauge block, with the springs or their equivalents, combined, for the purpose of feeding the slats or strips properly to the match frame, and adjusting them therein, and also causing the ends of the match sticks to be on a level, to insure an equal immersion in the necessary compound with which they are covered."

121. For an *Improvement in Tooth Clothing for Picker Cylinders;* Robert Heneage, Lowell, Massachusetts.

Claim.—"I claim the improved manufacture of a metallic clothing of a pick cylinder, the same being made of a thin plate of metal, with the teeth cut or stamped out of it, and bent from and directly above, and so as to stand at angles with the spaces from which they are cut. Also, so arranging the base plates of the teeth on the periphery of a cylinder, or the surface to which they are to be fastened, that one of said base plates shall overlap the other, and extend over and cover the spaces, or out of which the teeth of the latter plate may have been formed, the same serving not only to give support to the teeth, but to prevent such spaces from becoming clogged with fibrous material, or other matter, when the cylinder is in use, and also to increase the pitch of the front ends of the teeth beyond what they would have were the entire lower surface of each strip made to rest upon the surface of the cylinder."

122. For an *Improvement in Fire Arms;* John C. Howe, Milwaukie, Wisconsin.

Claim.—"I claim the arrangement of the breech operating lever by its hinges or joints, with the breech hung, and movable guide or slide at the back of the breech."

123. For an *Improvement in Machinery for Making Rope and Cordage;* John Harris, Lansingburgh, John B. Scott and Galen Richmond, Troy, New York.

Claim.—"We claim, 1st, The arrangement of the gears upon shaft, in combination with the clutch upon shaft, so that by changing the position of the clutch, we increase, retard, or arrest the motion of the friction rim, and reverse these motions instantly. 2d, The spider, arranged in combination with the cam and the spiral spring upon the shaft, to give it a revolving motion to rub the strands."

124. For *Improved Seats for Wagons;* Chesley Jarnagin, Clinton, Tennessee.

Claim.—"I claim making and attaching to the running gear of wagons, a safe, comfortable, and convenient seat for wagon drivers."

125. For an *Improvement in Machinery for Picking Cotton and other Fibrous Substances;* Richard Kitson, Lowell, Massachusetts.

Claim.—"I claim, 1st, Providing the cylinder or other foundation to which the picking teeth are secured, with orifices or perforations distributed in all directions among the teeth, for the purpose of blowing a number of streams of air among the teeth from the underside of and through the fibre, and thereby expelling outwardly, during the picking operation, all dust and dirt, and loosening the fibres, and finally blowing them from the teeth. 2d, The method of securing the teeth in the cylinder, by means of notched strips and shoulders on the teeth."

126. For an *Improvement in Tailors' Measuring Instruments;* John M. Krider, Newtown, Stephensburgh, Virginia.

Claim.—"I claim the use of the protractor at the point indicated, for the purpose of determining the cardinal point at the top of the back seam."

127. For *Attachment to Siphon;* Samuel Lenher, Philadelphia, Pennsylvania.

Claim.—"I claim so constructing a siphon that its long leg near the lower end thereof shall be surrounded with an elastic substance, as tow, cotton, india rubber, &c., forming a piston upon the exterior of said hollow leg, in combination with a cylinder, in which said piston may slide, for the purpose of creating a flow of liquid through the siphon by a quick withdrawal of the cylinder, without its coming in contact with the piston."

128. For an *Improved Tailors' Measure;* Warren Lillibridge and Charles F. Lillibridge, Zanesville, Ohio.

Claim.—"We claim the construction of flexible measures, so as to retain and show the form as well as the dimensions of the surface measured."

129. For an *Improvement in Railroad Car Axles;* James E. M'Connell, Wolverton, England.

Claim.—"I claim the constructing of hollow axles of bars of wrought iron running lengthwise, the edges lapping into each other by joints, which are welded and worked into form."

130. For an *Improvement in Cartridges for Breech Loading Fire Arms;* Dan. Moore, Williamsburgh, New York.

Claim.—"I claim the cone of paper or other suitable substance attached to and entering the rear end of the breech loading cartridge, to concentrate and pass the flash from a detonating cap."

131. For an *Improved Powder Flask for Breech Loading Guns;* D. Moore, Williamsburgh, New York.

Claim.—"I claim the method of loading fire arms from the breech by means of the pipe, so constructed and attached to the powder flask that the same forms a ramrod to force the ball into the barrel the required distance, and at the same time measure the powder for filling the chamber behind the ball."

132. For an *Improved Arrangement of Mechanism for Sawing off Piles under Water;* Vincent Palen, Portsmouth, Virginia.

Claim.—"I claim the combination of the devices for guiding and holding the saw up to the kerf, so as to prevent it from cramping and buckling in its kerf, the same consisting in the arrangement of the guides and saw shaft on the adjustable frame."

133. For an *Improved Pen and Pencil Case;* John Richardson, City of New York.

Claim.—"I claim the construction and arrangement of a pen and pencil case, so that by the acts of extending and contracting the case, either the pen or pencil can be protruded and drawn in."

134. For an *Improvement in the Manufacture of Bricks;* L. E. Ransom, Havana, O.

Claim.—"I claim the manufacture of bricks by first spreading the tempered mortar or clay at once upon the ground where the bricks will be left to dry, and in beds of certain desired length, width, and thickness, and then, while the mortar is in a soft state, or before it shall crack by too much drying, producing therein lines of weakening or separation, defining the dimensions of the bricks, without regard to their smoothness or final finish, and after the bricks, in drying, shall have separated from each other along the lines thus formed, turning them on edges, and squaring and polishing their edges, and defining the thickness of the same by rubbing over them the metallic tool, or otherwise; the desired thickness of the bed being produced by means of guide bars or moulds, and scraper or lute, whereby I am enabled to dispense with off-bearers, and otherwise to simplify the manufacture of bricks."

135. For a *Machine for Manufacturing Mast Hoops;* E. W. Scott, Lowell, Mass.

Claim.—"I claim the feed rolls, L and K, the feed rolls, I and J, and the cutters and cutter heads, when they are so constructed, arranged, and operated as to round or finish and shape the mast hoops while passing the said cutters and rolls, which shape, round, or finish them, parallel to the grain, the hoops being at liberty to take their natural course, excepting where they are held by the feed and friction rolls, and where the cutter heads and cutters are operating to dress them."

136. For an *Improved Soldering Furnace;* Wm. J. Stevenson, City of New York.

Claim.—"I claim providing a soldering furnace with an air tube and a recess, or their equivalents, so that the entire circumference of each of the joints of the can shall be soldered all at once, and during the performance of the same, no other parts of the can, besides the lap and that portion of the bottom or top upon which the ring of solder lies, exposed to a melting heat."

137. For an *Improvement in Odometers;* Samuel R. Thorp, Batavia, New York.

Claim.—"I claim the combination of the spring with the band and the ratchet wheel."

138. For an *Improvement in Odometers;* Julius Thompson, Middleborough, Mass.

Claim.—"I claim communicating motion from the wheel of the vehicle to the working parts of the odometer, by means of a cylindrical weight or wheel placed within the

case of the implement, and detached therefrom, so that said weight or wheel will, by its own gravity, remain at the lower part of the case, and in one position, and by the arrangement herein shown, viz: the fork and eccentric, or other suitable device, communicate the necessary motion to the working parts of the implement as the case rotates."

139. For an *Improvement in Grate Bars;* Samuel Vansyckel, Little York, N. J.

Claim.—"I claim the casting or forming of the pin, dowel, or catch, in one bar or set with a corresponding hole, or its equivalent, in the next bar or set, so that when put together they shall be held from warping, twisting, or dropping from the end plates or walls."

140. For an *Improved Arrangement in Spark Arresters for Heating Feed Water;* R. A. Wilder, Schuylkill Haven, Pennsylvania.

Claim.—"I claim the arrangement of the water space, the flue spaces, and the perforated cone, all concentric with each other."

141. For a *Water Metre;* S. R. Wilmot, New Haven, Connecticut.

Claim.—"I claim, 1st, Extending the sides of the piston upwards in the form of a tube, to enter an open bottomed but close topped chamber, in which a quantity of air, or its equivalent, is so confined as to press equally on the water above and below the piston, and thus prevent it overflowing the top of the tube on either side, and hence to form an effectual air seal or packing, and allow the piston to be fitted to the cylinder so loosely as to produce no friction. 2d, Enclosing all the mechanism by which the valves are actuated within the cylinder itself, or in a chamber in free communication with the same, whereby the necessity for stuffing boxes or other packing for the valves, rods, or other parts connected with the valves, and the consequent expense of construction, and friction of such packing is obviated."

142. For an *Improvement in Machinery for Cutting Rags for Making Paper;* Alonzo S. Woodward, Lowell, and Benjamin F. Bartlett, Pepperell, Massachusetts.

Claim.—"We claim, 1st, The cylindrics, made, constructed and used for the purpose of cutting paper rags and other paper stock. 2d, Our before-described cylindrics, in combination with the cuttting knife. 3d, The combination of the two sets of feed rolls with the cylindrics and knife, one set of them, the feed rolls, running at a greater speed than the other set, for the purpose of evenning the stock before it reaches the cylindrics and cutting knife."

143. For an *Improvement in Surface Condensers;* Wm. Sewell, Brooklyn, N. York; patented in England, January 13th, 1854.

Claim.—"I claim, 1st, The elastic supplementary tube sheet. 2d, The method of preventing the endwise sliding or creeping of the tubes. 3d, So constructing the guard that it performs, in addition to its own duty, the further office of holding down the edges of the elastic tube sheet, preventing the entrance of water behind the same. And, lastly, the injection or showering apertures, in combination with a surface condenser, wherein the steam space is outside of the tubes, and which is also provided with proper entrances and dischargers for circulating water through the tubes, whereby a surface condenser may be converted, at will, into a jet condenser."

ADDITIONAL IMPROVEMENTS.

1. For an *Improvement in Machinery for Polishing Raw Hide Whips;* Chas. Baeder, City of New York; dated Oct. 17, 1854; original patent dated May 21, 1850.

Claim.—"I claim the combination of the endless belt with the bearer, for smoothing and polishing raw hide whips, said bearer furnishing the facility for examining the progress of the operation."

2. For an *Improvement in Whiffle Tree Hooks;* Martin Newman, 2d, and N. C. Whitcomb, Lanesborough, Pennsylvania, and G. C. Cole, Hartford, Connecticut; dated October 31st, 1854; original patent dated February 21st, 1854.

Claim.—"We claim the construction of a trace fastened on the ends of a whiffle-tree, consisting of a rolling latch turning on a pin spring, in combination with a hook and catch or detent thereon."

3. For an *Improved Safety Washer for Securing Wheels to Axles;* Wm. Thornley, Philadelphia, Penna.; dated Oct. 31, 1854; original patent dated Sept. 19, 1854.

Claim.—"I claim a washer with a projecting flanch and two stops, as described."

RE-ISSUES.

1. For an *Improvement in Sewing Machines;* Isaac M. Singer, City of New York; dated October 3d, 1854; original patent dated August 12th, 1851.

Claim.—"I claim giving to the shuttle an additional forward movement after it has been stopped to close the loop, for the purpose of drawing the stitch tight, when such an additional movement is given at and in combination with the feed motion of the cloth in the reverse direction, and the final upward motion of the needle, so that the two threads shall be drawn tight at the same time. Also, controlling the thread by what I have termed the friction pad between the seam and the bobbin, or any equivalent therefor, and for any or all of the purposes specified. Also, placing the bobbin from which the needle is supplied with thread, on an adjustable arm attached to the frame, when this is combined with the carrying of the said thread through an eye or guide attached to and moving with the needle carrier, or the equivalent therefor, whereby any desired length of thread can be given for the formation of the loop, without varying the range of motion of the needle. And, also, in a sewing machine, feeding the cloth or other substance to determine the space between the stitches by the friction of the surface of the periphery of the feed wheel, or any equivalent feeding surface, in combination with a spring pressure plate or pad, which gripes the cloth or other substance against such feeding surface."

2. For an *Improvement in Fire Arms;* Horace Smith and Daniel B. Wesson, Norwich, Connecticut; dated Oct. 11, 1854; original patent dated Feb. 14, 1854.

Claim.—"We claim the combining the percussion hammer, the piston slide, and the barrel, so that the said piston slide shall not only serve as a breech to the barrels, but at the same time as a means of conveying (by concussion,) to the priming of the cartridge at one end of the slide, the force of the blow of the hammer upon the opposite end of the slide. Also, the improvement in the carrier, whereby it is not only enabled to be moved downwards, while the breech slide is forward against the barrel or cartridge therein, but is caused to expel from the chamber in which it moves, the remainder of the cartridge, after such remainder has been retracted by the piston slide, and while the carrier is being elevated with another cartridge; the said improvement consisting in making the carrier with an opening or passage leading out of the cartridge chamber thereof, and of a width sufficient for the movement of the piston slide out of the carrier during the descent of the latter, and providing said carrier with one or more projections, or the equivalent thereof, which, when the carrier is elevated, shall be moved against the remainder of the cartridge, and elevate and expel it from the fire arm so stated, the breech slide or piston slide being formed as specified. Also, the arrangement and application of the percussion hammer with respect to the breech slide and the trigger guard lever, so that the hammer may be moved and set to full cock by the pressure or back action of the slide induced by the action of the trigger guard lever. And, also, the improvement of making the front end of the piston slide with a dove-tail recess, or its equivalent, for the purpose of enabling the slide to seize the metal or remainder of the cartridge, and withdraw it from the barrel, when it (the piston slide,) is next retracted, the said remainder being discharged from the slide by the upward movement of the carrier."

3. For an *Improvement in Caloriferes;* Samuel Whitmarsh, Northampton, Mass.; dated October 10, 1854; original patent dated August 17, 1852.

Claim.—"I claim the combination of the water supply reservoir, the chamber or bed of sand, and a furnace or chamber of combustion."

4. For an *Improvement in Smut Machines;* John Hollingsworth, Zanesville, Ohio; dated October 10, 1854; original patent dated April 22, 1851.

Claim.—"I claim the manner of scouring and freeing wheat of smut and other impurities, by throwing the mass out of the concave at each revolution of the beaters, and against the inclined or curved face of a chimney fitted to an opening at or near the top of the concave, for the purpose of permitting the dust, smut, &c., to pass out, whilst the wheat is returned back into the machine for a second operation. Also, in combination with the concave, the adjustable inclined aprons, for conveying the grain through the concave as it is successively returned back into the machine."

5. For *Improvements in Rakes to Grain Harvesters;* Jearum Atkins, Chicago, Illinois: dated October 31, 1854; original patent dated December 21, 1852.

Claim.—"I claim the means of transmitting motion from the driving wheel to the

raking apparatus. Also, secondly, the collecting, grasping, and depositing of the cut product, by means of a rake and palm."

DESIGNS FOR OCTOBER, 1854.

1. For *Franklin Stoves;* William Reser, Cincinnati, Ohio; dated Oct. 3, 1854.

Claim.—"The ornamental design and configuration."

2. For *Clock Case Fronts;* Charles Chinnock, City of N. York; dated Oct. 17, 1854.

Claim.—"The design and configuration, termed the 'Three Bells' pattern."

3. For *Clock Case Fronts;* Charles Chinnock, City of N. York; dated Oct. 17, 1854.

Claim.—"The design and configuration, termed the 'Harlem Gothic' pattern."

4. For *Clock Case Fronts;* Charles Chinnock, City of N. York; dated Oct. 17, 1854.

Claim.—"The design and configuration of the base, pilaster, buttresses, cornice, crown piece, and ornaments."

5 For a *Franklin Stove;* William Reser, Cincinnati, Ohio; dated October 17, 1854.

Claim.—"The ornamental design and configuration of the stove plate."

6. For a *Cooking Stove;* Wm. P. Gray, Assignor to Cox, Hager & Cox, Philadelphia, Pennsylvania; dated October 17, 1854.

Claim.—"The design, configuration and arrangement of the several ornaments in bas relief, and mouldings on the front, sides, and feet of the stove 'Atlantic.'"

7. For *Franklin Fire Places;* Nathaniel S. Prince, Boston, Mass., Assignor to Franklin, Muzzy & Co., Bangor, and A. Lambard, Augusta, Me.; dated Oct. 31, 1854.

Claim.—"The ornamental design of the front of the fire place, the folding blower, the top plate, and the side."

8. For *Brackets;* Isaac De Gouche, Troy, New York; dated Oct. 31, 1854.

Claim.—"The ornamental configuration and design."

NOVEMBER 7.

1. For an *Improvement in Sewing Machines;* Daniel C. Ambler, City of New York.

Claim.—"I claim, 1st, The method of sewing a felling down, or zig-zag seam, by means of vibrations in a line perpendicular to the seam, or nearly so, imparted either to the needle or to the cloth. 2d, The combination with the needle having such motions, or the equivalent thereof, of a shuttle thrown in the direction perpendicular, or nearly so, to the general direction of the seam. 3d, An automatic lever for clamping the thread upon the up stroke of the needle. 4th, Imparting to the needle a partially reciprocating rotating motion upon its own axis. And, lastly, connecting two vibrating needles, each to each, whereby one vibrating mechanism serves for both needles, and said needles may also be adjusted so as to sew seams simultaneously at any required distance apart."

2. For an *Improvement in Locks;* John B. Brennan, Mount Vernon, New York.

Claim.—"I claim placing the sliding tumblers between two arms, one of which is attached to the bolt, and the other arm to the bolt tumbler, the tumblers having recesses cut in them at each end."

3. For an *Improvement in Machinery for Polishing Stone;* Albert Broughton, Malone, New York; ante-dated October 24th, 1854.

Claim.—"I claim causing the stones polished to be rotated around their own axes, or the axes of their receiving frames, by the polishing friction produced by the rotating polishing surface upon said stones."

4. For an *Improved Trap for Animals;* Robert S. Craig, Cincinnati, Ohio.

Claim.—"I claim the mechanical combination of the machinery."

5. For an *Improved Joint in Water Wheels;* Reuben Daniels, Woodstock, Vermont.

Claim.—"I claim the peculiar construction of the joint between the rims of the shute

and wheel, that is to say, the upper edge of the rim of the wheel being rabbeted on the inside, and the under edge of the rim of the shute being rabbeted on the outside, so as to match together."

6. For an *Improvement in Stone Drilling Machines;* F. Davison, Petersburgh, Va.

Claim.—"I claim the peculiar device for clamping and releasing the drill bars, consisting of the dog, to which the chain, or its equivalent, is attached, and the trigger for locking and unlocking the same on the drill bar, said dog and trigger being constructed, combined, and arranged within the catch block, so that the latter locks the former at the termination of the descent of the catch blocks, and unlocks it at the termination of the ascent thereof, by striking some part of the framings of the machine, or certain fixtures provided for the purpose."

7. For an *Improvement in Glass Furnaces;* Jacob Green, Philadelphia, Pennsylvania.

Claim.—"I claim the introduction of a blast of hot air among the combustible gases, after they have left the fire chamber, and during their passage through an intermediate flue, so that the combustible gases and hot air may enter the furnace together well mixed, and through the presence of a sufficient supply of oxygen effect an entire or nearly entire combustion of carbon and other combustible matter in the furnace, and consequently a great saving of fuel and better color and quality of glass."

8. For an *Improvement in Corn Shellers;* Samuel Gumaer, Aurora, Illinois.

Claim.—"I claim, 1st, The carrying up of the ears of corn from the hopper against the brake, by means of the rotation of the cylinder, where the larger portions of the ears are first reduced, preparatory to their being finally divested of the grains."

9. For an *Improvement in the Manufacture of Buckles;* Sheldon S. Hartshorne, Orange, Connecticut.

Claim.—"I claim the manufacture of a buckle of three parts, by dies or swedges, in such manner that the two ends of the wire of the main frame shall be secured by the socket of the tongue part, while the other part will have a free independent motion, when the whole is constructed and fitted for use."

10. For an *Improvement in Glass Furnaces;* A. K. Hay, Winslow, New Jersey.

Claim.—"I claim a trench around a central fire pot, and between it and the seiges."

11. For *Barrel Machinery;* Horace S. Higgens, Graham, Indiana.

Claim.—"I claim the combination of the shaft with the sectional expanding cutter rim."

12. For an *Improvement in Bottle Stoppers;* T. Kendall, San Francisco, California.

Claim.—"I claim the constructing of bottles, jugs, or jars, with a tri-threaded screw in the neck of each, for the purpose of holding safely the cork or stopper thereof, and the convenience of inserting or withdrawing the same, the threads of the said screw having the peculiar form and beveled surface indicated by the form of the core on which said bottle necks are to be formed."

13. For an *Improvement in Furnaces for Heating Buildings;* Joseph Leeds, Philadelphia, Pennsylvania.

Claim.—"I claim, in combination with the chamber above the fire box, the deflector and frustrum, with the exit pipe passing through it, for the purpose of regulating the draft and throwing it from the centre towards the sides of the burning mass, and thus produce equable combustion."

14. For an *Improvement in Vulcanizing Elastic Gums;* E. E. Marcy, City of N. Y.

Claim.—"I claim the combination of selenium with india rubber, as a curing or vulcanizing agent."

15. For an *Improvement in Coal Hods;* Wm. N. Martin, Bristol, Rhode Island.

Claim.—"I claim separating the main central chamber of a coal hod or bucket from the outer sides and bottom of the same, by an interior lining of sheet metal partially perforated, or of sheet metal and wire grating, combined in such a manner as to form a dust chamber between said lining and the exterior of the hod or bucket, open at the rear and closed in front, by which the coal only will be discharged at the front side of the bucket, and the dust be deposited in the said dust chamber, and when the coal is all discharged

from the bucket, the dust can be removed from its receptacle therein, by movements the reverse of those required in discharging the coal from its receptacle."

16. For an *Improvement in Potato Diggers;* Ives W. McGaffey, Philadelphia, Penna.

Claim.—"I claim arranging two endless chains of elevators on drums, (which have their axes standing at right angles, or nearly so, to the screen and digger,) and having the elevators of one of said chains come opposite the spaces between the elevator of the other chain."

17. For an *Improved Mode for Sawing Bolts for Staves;* B. McKeage, Accatink, Va.

Claim.—"I claim the improved form of the segments from which blocks for staves are to be cut, to wit: the sides of said segments being tangential to a circle around and concentric with the heart of the log from which said segments are formed."

18. For an *Improvement in Bombs, Shells, or Grenades;* E. T. Miller, Boston, Mass.

Claim.—"I claim the combination of the barrels and chambers."

19. For an *Improvement in Manufacturing Leather Banding for Machinery;* George Miller, Providence, Rhode Island.

Claim.—"I claim my improved manufacture of round banding, that is to say, by reducing a strip of leather, or other suitable material, to the shape denoted, and subsequently rolling and cementing it together."

20. For a *Slate Frame;* Edmund Morris, Burlington, New Jersey."

"My invention consists in forming the frame out of a solid piece by sawing out the centre and then cutting a kerf along and through each end of the frame, through which the kerf may be inserted and adjusted in a groove previously cut to receive it."

Claim.—"I claim the mode of constructing a slate frame as described."

21. For an *Improvement in Railroad Car Brakes;* M. P. Norton, Tinmouth, Vt.

Claim.—"I claim the arrrangement of machinery by which the action of the rubber or rubbers is confined to that part of the car wheel which, as the car is moving, is forward and moving downward, and when the direction of the car is reversed, brings another rubber or set of rubbers to act upon the other side of the wheel, which is then in like manner forward and moving downward."

22. For an *Improved Farm Gate;* Dewey Phillips, Shaftsbury, Vermont.

Claim.—"I claim, 1st, The adjustable lever of any desirable length and dimensions, or its equivalent. 2d, The adjustable lever, combined and arranged with the gate and posts, which will produce the desired effect."

23. For an *Improvement in Desulphurizing Gutta Percha and like Gums;* Wm. E. Rider and John Murphy, City of New York.

Claim.—"We claim extracting the superfluous portion of the sulphur from gutta percha, india rubber, and vulcanizable gums or gum goods, during the heating portion of the vulcanizing process, by the use of hydrogen gas in the apartment in which said heating process is performed, by which the after accumulation of sulphur upon the surface of said gums is prevented, and, consequently, the necessity of boiling them in caustic alkali entirely avoided."

24. For a *Machine for Cutting Tenons on Blind Slats;* E. W. Roff, Newark, N. J.

Claim.—"I claim the employment or use of the gauge, applied to an adjustable frame."

25. For an *Improvement in Steam Engine Valves;* C. Rumley, Rochester, N. York.

Claim.—"I claim the combination of the compound valve seat, consisting of an adjustable and a self-adjusting segment, with a rotating wing valve revolving isochronally with the piston."

26. For an *Improvement in Rotary Engines;* C. Rumley, Rochester, New York.

Claim.—"I claim making the internal curvature of such a cylinder for such a purpose, to coincide with those portions of the lines of two or three intersecting circles, of equal radius, and described from centres occupying the relative positions described, which are exterior to the points of intersection, whereby the construction of an elliptical cylinder

is greatly simplified, so that it may be bored with precision with an ordinary boring engine."

27. For an *Improvement in Machinery for Making Hat Bodies;* Isaac Searles, Newark, New Jersey.

Claim.—"I claim, 1st, The brush feeding roll, in combination with the metallic bar. 2d, The use of two or more pickers, when used to throw the fur on all sides of one and the same cone or wire gauge, for the purpose of laying the fibres of fur in all directions without depending on the rotary motion of the cone to equalize the thickness."

28. For an *Improvement in Harness Saddles;* Robert M. Selleck, City of New York.

Claim.—"I claim the depressions formed on each side of the head of the cast iron saddle tree, in combination with the gullet piece, the tongue of said gullet piece serving as a tack hold. 2d, Providing the flaps with tongues which pass under the lower parts of the frame while the flaps pass on top of the same. 3d, Making the false seat of tin, and separate from the cantel."

29. For an *Improved Form for and Mode of Operating Circular Saws;* James Slater, Macon, Georgia.

Claim.—"I claim cutting out portions of the edge of the saw at points opposite to one another, and arranging it in such relation to the crank pin that its teeth will not come in contact with the board or log, while the said crank pin is on either of the dead centres."

30. For an *Improvement in Corn Shellers;* J. P. Smith, Hummelstown, Penna.

Claim.—"I claim, 1st, The jointed shelling bars, having rests and springs, in combination with the springs and guides. 2d, I claim the vibrating feeder."

31. For an *Improved Means for Directing the Blast in Furnaces;* B. H. Washington, Hannibal, Missouri.

Claim.—"I claim the employment or use of the two hollow cones or funnels, said cones or funnels being applied as described, or in any other way, to produce the desired effect."

32. For a *Machine for Head part of Shovel Handles;* Elbridge Webber, Gardiner, Me.

Claim.—"I claim the longitudinal and lateral moving cutters, operating simultaneously on opposite sides of the handle, in combination with the cams moving the carriages, and the rotary support of the handle."

33. For an *Improvement in Locks;* Charles Wilson, Springfield, Massachusetts.

Claim.—"I claim the combination of series of opposite tumblers attached to and moving with the bolt."

34. For an *Improvement in Fire Arms;* Wendell Wright, City of New York.

Claim.—"I claim, 1st, The employment or use of the thumb trigger, F, arranged and connected with the cocking trigger, K, so that the trigger, F, may be operated by the thumb while the trigger, K, is operated by the hand. 2d, Counter-sinking the end of the stop which locks or retains the cylinder as each chamber is fired, for the purpose of enabling said stop to enter the chambers when the cartridge or powder and balls are within them. 3d, The flexible pin at the end of the hammer, whereby the pin is enabled to adjust itself to the vents of the chambers, and thus insure the ignition of the pills. 4th, The nipper boss at the side of the cylinder, when said boss is inserted within a cavity in the cheek piece, and encompassed by a fire ring, for the purpose of preventing the explosion of more than a single chamber at once, or at one operation of the trigger."

35. For an *Improvement in Loom Beams;* Samuel T. Thomas, Laurence, Mass., and Eliza Ann Everett, Adm'x. of Edward Everett, dec'd., late of Laurence, Mass.

Claim.—"What is claimed is, forming the loom beam of sectional parts or beams, which, when arranged side by side on a shaft from the entire loom beam, ready for insertion in the loom, by which arrangement the length of the loom beam may be varied, and a variety in the stripes produced by simply varying the relative positions of the sectional loom beams in the looms."

36. For an *Improvement in Carriage Lifting Jacks;* John Jenkins, Monroe, Assignor to Roe, Horton & Co., Chester, New York.

"The nature of my improvement consists in arranging the axle seat of lifting jacks in

such a manner that it will, no matter what may be the position or angle of the lifting lever, be capable always of assuming a horizontal position when the weight of the carriage comes upon it."

Claim.—"I claim the arrangement of the axle rest or seat."

37. For an *Improvement in Stone Dressing Machines;* John P. Avery, Assignor to J. B. Bromley, Norwich, Connecticut.

Claim.—"I claim the combination and arrangement with the revolving face plate, or its equivalent, of the rotating taper or conical picks or cutters, operating throughout their length on the stone to face it, with a velocity or movement on their axes proportioned to the varied velocity given them by the revolving face plate which carries and drives them."

MECHANICS, PHYSICS, AND CHEMISTRY.

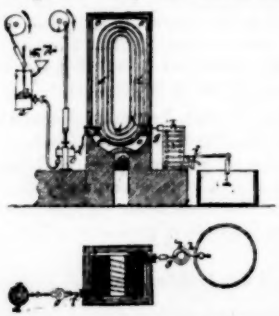
Specification of the Patent granted to RICHARD ALBERT TILGHMAN, *of Philadelphia, U. S. of America, Chemist, for Improvements in Treating Fatty and Oily Matters, chiefly Applicable to the Manufacture of Soap, Candles, and Glycerine.*—Dated January 9, 1854.*

The first part of my said invention consists of a mode or modes of obtaining free fat acids and solution of glycerine from those fatty or oily bodies of animal and vegetable origin which contain glycerine as their base.

For this purpose I subject these fatty or oily bodies to the action of water at a high temperature under pressure, so as to cause the elements of those bodies to combine with water, and to obtain at the same time, free fat acids and solution of glycerine.

I mix the fatty body to be operated upon with from a third to a half of its bulk of water, and the mixture may be placed in any convenient vessel in which it can be subjected to the action of heat, to a temperature about the same as that of melting lead, until the operation is complete; and the vessel must be closed, so that the requisite amount of pressure may be applied to prevent the conversion of the water into steam.

The process may be performed more rapidly and also continuously by causing the mixture of fatty matter and water to pass through a tube or continuous channel heated to the temperature already mentioned, the requisite pressure for preventing the conversion of the water into steam being applied during the process; and this I believe is the best mode of carrying this part of my invention into effect.



In the drawing hereunto annexed are shown figures of an apparatus for performing this process speedily and continuously, but which apparatus I do not intend to claim as any part of my invention.

Fig. 1, is a vertical section of this apparatus; and

Fig. 2, shows the various parts of the apparatus in horizontal section; I place the fat or oil in a fluid state in the vessel, *a*, with from one-third to one-half its bulk of warm water; the disk or piston, *b*, perforated with numerous small holes, being kept in rapid motion up and down in

* From the Repertory of Patent Inventions, Nov. 1854.

the vessel, *a*, causes the fat or oil and water to form an emulsion, or intimate mechanical mixture. A force pump, *c*, like those in common use for hydraulic presses, then drives the mixture through a long coil of very strong iron tube, *d*, *d*, *d*, *d*, which being placed in a furnace, *e*, *e*, is heated by a fire, *f*, to about the temperature of melting lead. From the exit end, *g*, of the heating tubes, *d*, *d*, the mixture, which has then become converted into free fat acids and solution of glycerine, passes on through another coiled iron tube, *h*, *h*, *h*, immersed in water, by which it is cooled down from its high temperature to below 212° Fah., after which it makes its escape through the exit valve, *i*, into the receiving vessel. The iron tubes I have employed and found to be convenient for this purpose, are about one inch external diameter, and about half an inch internal diameter, being such as are in common use for Perkins's hot-water apparatus. The ends of the tubes are joined together by welding to make the requisite length; but where welding is not practicable I employ the kind of joints used for Perkins's hot-water apparatus, which are now well known. The heating tube, *d*, *d*, *d*, is coiled several times backwards and forwards, so as to arrange a considerable length of tube in a moderate space. The different coils of the tube are kept about one-quarter of an inch apart from each other, and the interval between them is filled up solid with cast iron, which also covers the outer coils or rows of tubes to the thickness of half or three-quarters of an inch, as shown in fig. 2. This casing of metal insures a considerable uniformity of temperature in the different parts of the coil, adding also to its strength and protecting it from injury by the fire.

The exit valve, *i*, is so loaded that when the heating tubes, *d*, *d*, *d*, are at the desired working temperature, and the pump, *c*, is not in action, it will not be opened by the internal pressure produced by the application of heat to the mixture, and therefore when the pump, *c*, is not in action, nothing escapes from the valve, *i*, if the temperature be not too high. But when the pump forces fresh mixture into one end, *j*, of the heating tubes, *d*, *d*, *d*, the exit valve, *i*, is forced open to allow an equal amount of the mixture which has been operated upon to escape out of the cooling tubes, *h*, *h*, at the valve, *i*, placed at the other end of the apparatus. No steam or air should be allowed to accumulate in the tubes, which should be kept entirely full of the mixture. For this purpose, whenever it may be required, the speed of the pump should be increased, so that the current through the tubes may be made sufficiently rapid to carry out with it any air remaining in them. Although the decomposition of the neutral fats by water takes place with great quickness at the proper heat, yet I prefer that the pump, *c*, should be worked at such a rate in proportion to the length or capacity of the heating tubes, *d*, *d*, *d*, that the mixture while flowing through them should be maintained at the desired temperature for about ten minutes before it passes into the refrigerator or cooling parts, *h*, *h*, of the apparatus.

The melting point of lead has been mentioned as the proper heat to be used in this operation, because it has been found to give good results; but the change of fatty matters into fat acids and glycerine takes place with some materials (such as palm oil) at the melting point of bismuth,

yet the heat has been carried considerably above the melting point of lead without any apparent injury, and the decomposing action of the water becomes more powerful as the heat is increased. By starting the apparatus at a low heat and gradually increasing it, the temperature giving products most suitable to the intended application of the fatty body employed, can easily be determined.

To indicate the temperature of the tubes, *d*, *d*, *d*, I have found the successive melting of metals and other substances of different and known degrees of fusibility to be convenient in practice. Several holes half an inch in diameter and two or three inches deep are bored into the solid parts of the casting surrounding the tubes, each hole being charged with a different substance. The series I have used consist of tin, melting at about 440°, bismuth at about 510°, lead at about 612°, and nitrate of potash at about 660°. A straight piece of iron wire passing through the side of the furnace to the bottom of each of the holes, enables the workman to feel which of the substances are melted, and to regulate the fire accordingly. It is important for the quickness and perfection of the decomposition that the oil and water during their entire passage through the heating tubes should remain in the same state of intimate mixture in which they enter them. I therefore prefer to place the series of heating tubes in a vertical position, so that any partial separation which may take place while the liquids pass up one tube, may be counteracted as they pass down the next. I believe that it will be found useful to fix at intervals in the heating tubes of such apparatus as may admit of such an addition, diaphragms pierced with numerous small holes, so that the liquids being forced through these obstructions may be thoroughly mixed together. I deem it prudent to test the strength of the apparatus by a pressure of 10,000 lbs. to the square inch before taking it into use; but I believe that the working pressure necessary for producing the heat I have mentioned, will not be found to exceed 2000 lbs. to the square inch. When it is desired to diminish the contact of the liquids with iron, the tube or channels of the apparatus may be lined with copper.

The hot mixture of fat acids and solution of glycerine which escape from the exit valve of the apparatus are separated from each other by subsidence; the fat acids may then be washed with water, and the solution of glycerine concentrated and purified by the usual means.

The fat acids thus produced may, like those obtained by other methods, be used in the manufacture of candles and soap, and applied to various purposes according to their quality; and when desired they may also be first bleached or purified by distillation or otherwise, as is now well understood.

I prefer that the fatty bodies should be previously deprived, as far as practicable, of such impurities as would cause the discoloration of the fat acids produced; but when the fat acids are to be finally purified by distillation, this preliminary purification is of less importance.

When any acid or other corrosive agent shall have been used for purifying, hardening, or otherwise preparing the fatty body to be operated upon, I take care that all traces of it shall be washed out or neutralized before passing it through the apparatus. Some fatty bodies (particularly

when impure) generate during the process, a portion of acetic or other soluble acid, which might tend to injure the iron tubes; in such cases I add a corresponding quantity of alkaline or basic matter to the water and oil before they are pumped into the tubes.

The second part of my said invention consists of a mode of treating a mixture of fatty matters (whether acid or neutral) and a carbonated alkali for the purpose of manufacturing soap.

For this purpose I mix the fatty bodies in a liquid state with the quantity of carbonated alkali in solution which may be necessary to convert it into soap, and then subject the mixture to a high temperature under pressure, in like manner as hereinbefore described in practising my mode of obtaining fatty acids and glycerine. And for this purpose the apparatus hereinbefore described for producing the fatty acids and glycerine by a continuous process may be used for the production of soap in a similar manner. The carbonated alkali may be dissolved merely in the quantity of water which is intended to remain in the soap produced. If resinous or other matters are intended to be used in the manufacture of the soap, they may be dissolved either in the alkali solution or the oil, or may be combined with the soap after it has left the apparatus.

The degree of heat required is less than that which is necessay to produce free fat acids, and should generally be kept between the melting points of tin and bismuth. At about 350° Fah. the neutral fats will form soaps, with the solution of alkaline carbonates, but a higher temperature will produce the result more quickly.

The carbonic acid expelled from the alkali in this process when performed in the apparatus above described, escapes as the soap issues from the exit valve; if but little water has been used, and the quality of the soap is sufficently good without further purification, it can be put into frames to harden at once, or it may be put into the coppers, boiled up, and separated from the glycerine (when neutral fats have been used), and finished in the usual manner.

I claim as of my invention,—

First, the manufacturing of fatty acids and glycerine from fatty bodies by means of water and heat acting thereon, as hereinbefore described; and

Secondly, the manufacturing of soap by treating a mixture of fatty matters and a carbonated alkali, as above described.

---

*On Magnetic Hypotheses.**

A discourse which was recently delivered at the Royal Institution, by Professor Faraday, the purpose of which was to direct the attention of the audience to the different hypothetical attempts made to account physically for the known properties of matter in relation to its magneto-electrical phenomena, followed on very naturally to one addressed to the Institution by Dr. Frankland on the 2d instant, who then gave an account of the different views advanced by Davy, Ampère, and Berzelius, of the

* From the Lond. Mech. Mag. July, 1854.

manner in which electricity might be associated with the atoms or molecules of matter, so as to account for their electro-chemical actions, and of the logical and experimental objections which stood in the way of each. On the present occasion reference was first made to Coulomb's investigations of mutual magnetic actions, to the hypothesis advanced by him, that two magnetic fluids, associated with the matter of magnetic bodies, would account for all the phenomena; and to Poisson's profound mathematical investigation of the sufficiency of the hypothesis. Then Oersted's discovery of the relation of common magnetism to currents of electricity was recalled to mind;—hence an enormous enlargement of the scope of magnetic force and of our knowledge of its actions; and hence Ampère's beautiful investigations; and his hypothesis (also sustained by the highest mathematical investigation),—that all magnetic phenomena are due to currents of electricity; and that in such bodies as magnets, iron, nickel, &c., the atoms or particles have naturally currents of electricity running around them in one direction, about what may be considered as their equatorial parts. After Oersted's time, further experimental discoveries occurred; currents of electricity were found competent to induce collateral currents, and magnets proved able to produce like currents, thus showing the identity of action of magnets and currents in producing effects of a kind different to ordinary magnetic attractions and repulsions. Then diamagnetism was discovered, in which actions analogous to those of ordinary magnetism occurred, but with the antithesis of attraction for repulsion and repulsion for attraction; and these were so extensive, that whatever bodies were not magnetic proved to be diamagnetic; and thus *all* matter was brought under the dominion of that magnetic force, whose physical mode of action hypothesis endeavors to account for. As the hypothesis of Ampère could not account for diamagnetic action, some assumed that magnetic and electric force might, in diamagnetic matter, induce currents of electricity in the reverse direction to those in magnetic matter, or else might induce currents where before there were none; whereas in magnetic cases it was supposed they only constrained particle-currents to assume a particular direction, which before were in all directions. Weber stands eminent as a profound mathematician who has confirmed Ampère's investigations as far as they proceeded, and who has made an addition to his hypothetical views,—namely, that there is electricity amongst the particles of matter, which is not thrown into the form of a current until the magnetic induction comes upon it, but which then assumes the character of current, having a direction the contrary to that of the currents which Ampère supposed to be always circulating round magnetic matter; and so these other matters are rendered diamagnetic.

De la Rive, who has recently most carefully examined the various hypotheses, and who, as an experimentalist and discoverer, has the highest right to enter into the consideration of these deep, searching, and difficult inquiries, after recalling the various phenomena which show that the powers concerned belong to the particles of matter, and not to the masses merely (the former conferring them by association upon the latter), then distinguishes magnetic action into four kinds or modes—namely, the ordinary, the diamagnetic, the induction of currents, and the rotation of a ray; and points out that any acceptable hypothesis ought to account for

the *four* modes of action, and, it may be added, ought to agree with, if not account for, the phenomena of electro-chemical action also. De la Rive conceives that as regards these modes of action, this hypothetical result may be obtained, and both Ampère and Weber's views also retained in the following manner: All the atoms of matter are supposed to be endowed with electrical currents of a like kind, which move about them for ever, without diminution of their force or velocity, being essentially a part of their nature. The direction of these currents for each atom is through one determinate diameter, which may therefore be considered as the axis. Where they emerge from the body of the atom they divide in all directions, and running over every part of the surface, converge towards the opposite end of the axis diameter, and there re-enter the atom to run ever through the same course. The converging and diverging points are, as it were, poles of force. Where the atoms of matter are close or numerous in a given space (and chemical considerations lead to the admission of such cases), the hypothesis then admits that several atoms may conjoin into a ring, so that their central or axial currents may run one into the other, and not return, as before, over the surface of each atom; these form the molecules of magnetic matter, and represent Ampère's hypotheses of molecular currents. Where the atoms, being fewer in a given space, are farther apart, or where, being good conductors, the current runs as freely over the surface as through the axis, then they do not form like groups to the molecules of magnetic matter, but are still considered subject to a species of induction by the action of external magnets and currents; and so give rise to Weber's reverse currents. The induction of momentary currents and the rotation of a ray are considered by De la Rive as in conformity with such a supposition of the electric state of the atoms and particles of matter.

The lecturer seemed to think that the great variety of these hypotheses, and their rapid succession, was rather a proof of weakness in this department of physical knowledge than of strength, and that the large assumptions which were made in turn for each should ever be present to the mind. Even in the most perfect of them, that is, De la Rive's, these assumptions are very considerable; for it is necessary to conceive of the molecules as being flat or disk-like bodies, however numerous the atoms of each may be; also, that the atoms of one molecule do not interfere with or break up the disposition of those of another molecule; also, that electro-chemical action may consist with such a constituted molecule; also, that the motive force of each atom current is resident in the axis, and on the other hand, that the passage of the current over the surface offers *resistance;* for unless there were a difference between the axial and the surface force in one direction or the other, the atoms would have no tendency to congregate in molecules. In making these remarks, however, the speaker had no thought of depreciating hypothesis, or objecting to its right use. No discoverer could advance without it; and such exertions as those made by De la Rive, to bring into harmony thoughts which in their earlier forms were adverse to each other, were of the more value, because they were the exertions of a man who knew the value both of hypothesis and of laws, of theory and of fact, and had given proofs of the power of each by the productions of his own mind. Still the speaker ad-

vocated that mental reservation which kept hypothesis in its right place, and which was ready to abandon it when it failed; and as examples, referred to Newton, who (as is shown by his letters to Bentley,) had very strong convictions of the physical nature of the lines of gravitating force, yet in what he publicly advanced stopped short at the law of action of the force, and thence deduced his great results; and also to Arago, who, discovering the phenomena of magnetic rotation, yet not perceiving their physical cause, had that philosophic power of mind which enabled him to refrain from suggesting one.

---

*On the Flow of Gas through Pipes.**†

In determining the size of main pipes capable of distributing given quantities of gas, it is necessary to combine certain empirical results derived from experiment with certain laws applicable to the movement of fluids. The modes of calculation usually resorted to for determining the dimensions of mains will be more simply discussed by dividing the subject under three separate heads: 1st, the motion of gas through simple orifices; 2d, its motion through horizontal pipes; and, 3d, its motion through pipes varying from the horizontal direction.

I. Motion through simple orifices.

The theoretical laws which apply to this case are the following:—

1. The velocity with which gas issues out of a simple orifice is as the square root of the head of water by which it is pressed. The gas in this case follows the simple law as water itself; and as the pressure applied to gas is usually estimated in inches of water, it is convenient to use this law in the form here expressed. Of course, the quantity of gas discharged through any orifice being in proportion to the velocity, all other things being alike, it follows that the quantity of gas passing through any simple orifice is as the square root of the pressure.

Let H be the height or depth of water in inches denoting the pressure on the gas, and let Q be the quantity of gas discharged through any orifice with that pressure. Let h be any other depth of water, also in inches, for which it is required to ascertain the quantity q. Then

$$\sqrt{H} : \sqrt{h} :: Q : q \text{ or } \frac{\sqrt{h}\,Q}{\sqrt{H}} = q \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

In order to illustrate this, it may be stated that the quantity discharged under 4 inches head of water will be twice as much as under 1 inch. The quantity under 9 inches will be three times as much as under 1 inch; and in the same proportion for any intermediate pressures.

The rule may be thus expressed in words. Multiply the quantity of gas delivered under the pressure of any known depth of water by the square root of the depth for which the quantity is required, and divide the product by the square root of the depth for which the quantity is known, the quotient will be the quantity delivered under the required pressure.

Suppose it has been ascertained by experiment, that under a pressure

* *Hughes' Treatise on Gas Works.* Lond. J. Weale.

† From the Lond. Artizan, Feb. 1, 1851.

of 3 inches of water 400 cubic feet of gas are discharged per hour through a certain opening, it is required to know how many cubic feet of the same gas will be discharged through the same opening with a pressure of 2 inches of water.

$$\text{Here} \frac{\sqrt{2} \times 400}{\sqrt{3}} = \frac{565{\cdot}6}{1{\cdot}732} = 327 \text{ cubic feet, the quantity required.}$$

2. The pressure remaining constant, the quantity of gas discharged through a simple orifice will be inversely as the square root of its specific gravity. It is evident that the lighter gas will flow out with a much higher velocity than the heavier, and the exact proportionate velocity of the two has long been proved to follow the law just quoted.

Let G be the specific gravity of a gas whose rate of delivery through any orifice in a given time is equal to Q, and let it be required to find the quantity q which will be delivered under the same circumstances when the gas has a specific gravity equal to g.

$$\text{Here } \sqrt{g} : \sqrt{G} :: Q : q \text{ or} \frac{\sqrt{G}\, Q}{\sqrt{g}} = q \quad . \quad . \quad . \quad (2)$$

Suppose it were known that cannel coal-gas of specific gravity ·550 were delivered out of an orifice at the rate of 400 feet per hour, and it is required to ascertain the rate at which a very light inferior gas of specific gravity ·380 would pass under the same pressure through the same orifice.

$$\text{Here} \frac{\sqrt{\cdot 550} \times 400}{\sqrt{\cdot 360}} = \frac{296{\cdot}64}{\cdot 6} = 494 \text{ cubic feet per hour, the quantity}$$

which would be delivered of the lighter gas.

3. The pressure and specific gravity remaining constant, the discharges of the same gas through different openings are as the areas of the openings, or as the squares of their diameters. Thus, all other circumstances being alike, an orifice of 2 inches diameter will discharge four times as much gas as one of 1 inch; an orifice of 3 inches diameter will discharge nine times as much; and so on.

This rule is not strictly correct in practice, being based on the theoretical supposition of an entire absence of friction. Since there is less proportionate friction in a large opening, the discharge in practice is more than that assigned by theory for large openings. Many gas engineers, however, have estimated the size of their mains according to this law, and have not thought it advisable to reduce the size below that given by theory, because the excess allows for errors and imperfections in laying the pipes, and for other contingencies which may obviously arise.

Let D be the diameter of any orifice through which the quantity Q can be discharged, then the quantity q which will be discharged through any other opening of the diameter d will be

$$\frac{d^2\, Q}{D^2} = q \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

For example, suppose 1000 feet of gas are discharged per hour through an orifice half an inch in diameter, required the quantity of the same gas which would be discharged through an orifice $4\frac{1}{4}$ inches diameter.

$$\text{Here} \frac{4{\cdot}25^2 \times 1000}{\cdot 5^2} = \frac{19062}{\cdot 25} = 76248, \text{ the quantity discharged through}$$

the large orifice. It is probable that several hundred feet more would be actually discharged than the quantity determined by theory, for the reason already stated.

We now come to the combination of practical results with the theoretical rules which have been laid down for determining what Mr. Clegg very properly calls the *initial* velocity of the gas—that is, the velocity with which it commences to flow through an opening, as distinguished from its velocity after passing through a main pipe of greater or less length. It is to be regretted that the practical experiments by which theory is to be compared, and in some cases modified, are here very scanty and insufficient. Mr. Clegg gives a table showing the quantities discharged through a very small circular orifice of only one-fourth of an inch diameter at different pressures, from half an inch up to 5 inches. On calculating the quantities which ought to be discharged in proportion to the discharge under the lowest pressure, the results are sufficiently near, as will be seen from the following comparison:—

Table of the quantity of carburetted hydrogen gas of specific gravity ·420 which will flow per hour through a circular orifice of one-fourth of an inch.

Pressure.	Quantity of Gas by experiment, in cubic feet.	Quantity of Gas by calculation, in cubic feet.
½ inch	80·	
1 "	113·	111·7
2 "	160·5	160·
3 "	195·	193·1
4 "	226·	226·2
5 "	253·	253·

Mr. Clegg has also another table showing the quantity of gas of specific gravity ·420 discharged by experiment and calculation, where pressure remains constant at half an inch, and the diameter of the orifice varies from one-fourth of an inch up to 6 inches.

Diameter of orifice in inches.	Quantities of Gas discharged in cubic feet per hour.	
	By experiment.	By calculation.
·25	80	
·50	321	320
·75	723	720
1·00	1287	1280
1·125	1625	1620
1·25	2010	2000
1·50	2885	2880
6·00	46150	46080

The excess in the experimental results is accounted for by the proportionate diminution of friction, as already explained.

Assuming the primary experiment, giving 80 cubic feet of gas of spe-

cific gravity ·420 discharged through one-fourth of an inch orifice, under a pressure of half an inch, to be strictly correct, and worthy of forming a basis; let it be required, by way of illustration, to determine the quantity of gas of specific gravity ·500 discharged per hour through a circular orifice of 4 inches in diameter, under a pressure of $2\frac{1}{2}$ inches of water.

First. To find the diminished quantity due to the increased specific gravity, we have

$$\frac{\sqrt{\cdot 420} \times 80}{\sqrt{\cdot 500}} = \frac{51 \cdot 84}{\cdot 707} = 73 \cdot 3,$$ the quantity discharged of specific gravity ·500.

Secondly. To find the increased quantity due to the larger orifice, we have

$$\frac{16 \times 73 \cdot 3}{\cdot 25^2} = \frac{1172 \cdot 8}{\cdot 0625} = 18765,$$ the quantity of gas having a specific gravity =·500 discharged through a circular orifice, 4 inches diameter.

Thirdly. To find the increased quantity due to the pressure of $2\frac{1}{2}$ inches, we have

$$\frac{\sqrt{2\frac{1}{2}} \times 18765}{\sqrt{\cdot 5}} = \frac{29649}{\cdot 707} = 41936,$$ the required quantity of specific gravity ·500 which will be discharged in one hour from a 4-inch circular opening, under a pressure of $2\frac{1}{2}$ inches of water.

We now come to the second and more important practical inquiry, namely, that of determining the quantities of gas which will flow through mains of given length and area.

Mr. Clegg quotes a series of six experiments, in which gas under a pressure of half an inch head of water was made to flow through various lengths of 6-inch pipe up to thirty-four yards. From these experiments he deduces the law that the quantities of gas discharged in equal times by a horizontal pipe, under the same pressure and for different lengths, are to one another in the inverse ratio of the square roots of the length. Taking as a basis Mr. Clegg's first experiment, which gave a discharge of 44,280 feet per hour, through a pipe 3·46 yards long, we shall find the quantity discharged through a pipe 34·20 yards long by this proportion,

$$\sqrt{34 \cdot 20} : \sqrt{3 \cdot 46} : : 44280 : \text{required quantity};$$

or $$\frac{44280 \times \sqrt{3 \cdot 46}}{\sqrt{34 \cdot 20}} = \frac{82361}{5 \cdot 848} = 14083 \cdot 6$$ cubic feet, while the quantity actually discharged by experiment is 14,080 cubic feet, an experiment sufficiently accurate for all practical purposes. This mode of calculating the discharge, although founded on a very scanty basis, appears to be the only one made use of by Mr. Clegg. Putting P for the product of the discharge through a 6-inch pipe by the square root of 3·46 yards the length of the pipe, and L the length in yards of any other 6-inch pipe, the discharge per hour through L will be equal to $\frac{P}{\sqrt{L}}$, and as in this case the value of P is known, being = 82361, the form becomes $\frac{82361}{\sqrt{L}}$. This

formula only applies to gas of the specific gravity ·420 under a pressure of half an inch head of water.

Putting D to represent any other diameter than 6 inches, we have the quantity discharged from such a pipe

$$=\frac{82361\ D^2}{36\sqrt{L}}=\frac{2288\ D^2}{\sqrt{L}}$$

Putting g to represent the specific gravity of any other kind of gas, that of atmospheric air being 1, we have the quantity discharged of such a gas

$$=2288\ D^2\frac{\sqrt{\cdot 420\ H}}{\sqrt{\cdot 5\ Lg}}=2288\ D^2\sqrt{\cdot 84}\sqrt{\frac{H}{Lg}}$$

$$=2096\ D^2\sqrt{\frac{H}{Lg}} \quad . \quad . \quad . \quad . \quad (4)$$

Also putting Q for the quantity of gas discharged per hour in cubic feet, we have

$$D=\sqrt{\frac{Q}{2096\sqrt{\frac{H}{Lg}}}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Mr. Clegg* has given a long series of tables, all calculated according to this formula, showing the quantities of gas of specific gravity ·420 delivered per hour from horizontal mains varying in length from 100 to 10,000 yards, and varying in diameter from 2 inches to 18 inches, under pressures varying from half an inch to 3 inches of water. There appears to be a general tendency to the belief that the actual quantities are much larger than those given in Mr. Clegg's tables, or, which is the same thing, those which would result from the formula (4). For instance, in the recent important parliamentary inquiry into the case of the Great Central Gas Consumers' Company, their engineer, Mr. Croll, estimated that with a pressure of 2½ inches a quantity equal to 173,000 cubic feet of gas would be delivered at the end of a 26-inch main, 2¼ miles in length. Now if we calculate the quantity of gas which would be delivered from a main of this kind according to the basis of Mr. Clegg's tables, we shall find it amount to less than half this quantity.

We have seen (equation 4) that a general expression in the form $xA=Q$ may be derived from any experiment, and that it is only necessary to determine the value of the coefficient x in this equation. The part A is always of course equal to $D^2\sqrt{\frac{H}{Lg}}$, so that the coefficient x is equal to

$$\frac{Q}{D^2\sqrt{\frac{H}{Lg}}}=\frac{Q\sqrt{Lg}}{D^2\sqrt{H}}$$

We shall now determine the value of x according to this equation from several other experiments on coal gas.

* The work by Mr. Clegg which is referred to here is the one published by Mr. Weale in 1841.

Table showing the quantities of Gas discharged from a Pipe 62·100 *of an inch in diameter, in the Experiments of M. Girard at the Hospital of St. Louis. In these Experiments the density of the Gas or the value of* g *was* ·559, *and the Pressure or value of* H *was* 1·34 *inches.*

Length of pipe in yards.	Quantity discharged per hour in cubic feet.	Value of x Calculated from the Equation $x=\frac{Q\sqrt{Lg}}{D^2\sqrt{H}}$
41	99	1065
62	83	1096
93	74	1198
119	57	1045
138	53	1047
		5) 5451
The coefficient according to these experiments		1090

It will be observed that the value of x calculated from these experiments varies from 1045 to 1198, being a difference between the extremes equal to 14 per cent. The fairest way to adjust this variation in the experiments is, therefore, to take the mean and to assume the coefficient established by M. Girard at 1090.

(To be Continued.)

---

*The Stereochrome of Fuchs.**

The formation of an insoluble cement by means of the water-glass, whenever the carbonic acid of the atmosphere acts on this substance, or whenever it is brought into contact with a lime-salt, has been applied by Fuchs to a most important purpose. The stereochrome is essentially the process of fresco secco,† invested with the capability of receiving and perpetuating works of the highest artistic character, and which may be executed on a vast scale. Fuchs's method is as follows:‡

"Clean and washed quartz-sand is mixed with the smallest quantity of lime which will enable the plasterer to place it on the wall. The surface is then taken off with an iron scraper, in order to remove the layer formed in contact with the atmosphere: the wall being still moist during this operation. The wall is then allowed to dry; after drying, it is just in the state in which it could be rubbed off by the finger. The wall has now to be *fixed*, *i. e.* moistened with water-glass.§ [An important point is not to

* From the London Chemical Gazette, No. 279.

† Vide Eastlake's Materials for a History of Oil Painting, p. 142.

‡ These particulars were obtained by Dr. Hofmann from Mr. Echter. A stereochromic picture by Echter, and a sample of the water-glass as prepared in Munich, were also exhibited by Dr. Hofmann.

§ The composition of the specimen was—

	per cent.
Silica,	23·21
Soda,	8·90
Potash,	2·52

[The specific gravity of the solution, 3·81.]

use too much water-glass in moistening the wall.] This operation is usually performed with a brush. The wall must be left in such a condition as to be capable of receiving colors when afterwards painted on. If, as frequently happens, the wall has been too strongly fixed, the surface has to be removed with pumice, and to be fixed again. Being fixed in this manner, the wall is suffered to dry. Before the painter begins, he moistens the part on which he purposes to work with distilled water, squirted on by a syringe. He then paints; if he wishes to repaint any part, he moistens again. As soon as the picture is finished, it is syringed over with water-glass. After the wall is dry, the syringing is continued as long as a wet sponge can remove any of the color. An efflorescence of carbonate of soda sometimes appears on the picture soon after its completion. This may either be removed by syringing with water, or may be left to the action of the atmosphere."

Not to dwell on the obvious advantages possessed by the stereochrome over the real fresco (such as its admitting of being retouched and its dispensing with joinings), it appears that damp and atmospheric influences, notoriously destructive of real fresco, do not injure pictures executed by this process.

The following crucial experiment was made on one of those pictures. It was suspended for twelve months in the open air, under the principal chimney of the New Museum, at Berlin; "during that time, it was exposed to sunshine, mist, snow, and rain," and nevertheless "retained its full brilliancy of color."

The stereochrome has been adopted on a grand scale by Kaulbach in decorating the interior of the great national edifice at Berlin, already alluded to. These decorations are now in progress, and will consist of historical pictures (the dimensions of which are 21 feet in height and 24¾ in width), single colossal figures, friezes, arabesques, chiaro scuro, &c. On the effect of the three finished pictures, it has been remarked by one whose opinion is entitled to respect, that they have all the brilliancy and vigor of oil paintings, while there is the absence of that dazzling confusion which new oil paintings are apt to present, unless they are viewed in one direction, which the spectator has to seek for.

---

*On the Composition of the Sheathing of Ships.**

M. Bobierre has paid considerable attention to this subject, and has arrived at the following conclusions as to the cause of the rapid destruction of some copper and bronze sheathing:—1. When unalloyed copper is employed, the presence of arsenic appears to hasten its destruction. 2. All bronzes which appear to have stood well, contained from 4½ to 5½ per cent. of tin, that quantity being necessary to form an homogeneous alloy. When the per centage of tin is only 2·5 to 3·5, which is very frequently the case, no definite alloy is produced, and the mass is of unequal composition, and being unequally acted upon, is soon destroyed. 3. When impure copper is employed, the alloy is never homogeneous, and is unequally acted upon in consequence. We thus see, that the so

* From the London Artizan, August, 1854.

frequent destruction of the sheathing of copper-bottomed vessels arises from the tendency to use inferior brittle copper, and by diminishing the proportion of tin, to economize the difference between the price of that metal and copper, at the same time that the cost of rolling is also less, in consequence of the greater softness of the poor alloy. Bobierre thinks that the addition of a very small portion of zinc very much improves the bronze, by producing a more perfect and uniform distribution of the positive metals, and consequently a much more definite alloy.—*Comptes Rendus*, vol. xxxvii., p. 131, and vol. xxxviii., p. 122.

---

*The Mints of the United States.** By Professor Wilson.†

The transmissions of gold from the new State of California, have caused a corresponding increase in the gold currency of the States, and have invested the Mint operations with more general interest than under the previous ordinary circumstances they possessed. The same condition of things exists in this country; and as it is intended to establish a mint in the gold producing colony of Australia, I thought it desirable to obtain as much information as I could in reference to the organization and working details of those in the United States.

The head establishment is at Philadelphia, and is called "The Mint;" there are also, three "Branch Mints;"—at New Orleans, in Louisiana; at Charlotte, in North Carolina; and at Dahlonega, in Georgia, respectively. The Branch Mint in California, and the Assay Office in New York, are not yet completely organized.

At the Mint in Philadelphia, gold, silver, and copper, are coined; at New Orleans, gold and silver are coined; while the branches at Charlotte and Dahlonega coin gold only. At "The Mint," the executive staff consists of a director, treasurer, chief coiner, melter and refiner, engraver, assayer, and assistant assayer. At the New Orleans Branch Mint, the staff consists of a superintendent, treasurer, melter and refiner, and coiner; and at each of the other two branch mints there are but three officers,—superintendent and treasurer (combined), assayer, and coiner. The several duties of these officers, the remuneration they shall receive for their services, and the amount of security they shall give for the due performance of them, are duly prescribed by an Act of Congress supplementary to the Act, entitled "An Act establishing a Mint and regulating the Coins in the United States;" this latter Act giving all the details referring directly to the coinage of the country.

At the United States Mint at Philadelphia, the salaries are fixed as follows:—Director, $3500; treasurer, $2000; chief coiner, $2000; melter and refiner, $2000; assayer, $2000. At the New Orleans Branch Mint the salaries are, to the superintendent, $2500, and $2000 each to the other officers; and at the other branch mints the superintendents receive $2000, and the other officers $1500 respectively. In each of the establishments, the appointment of assistants, subordinate officers and

* From the Civil Engineer and Architect's Journal, November, 1854.

† From the Special Report on the New York Industrial Exhibition.

servants, is left entirely in the hands of the chief of the different departments.

In visiting the Mint at Philadelphia I had the advantage of being taken through the several departments by the chief coiner, Mr. Franklin Peale, and the melter and refiner, Professor J. C. Booth, who kindly furnished me with the following details of their operations. As the gold is brought to the Mint in various quantities and in a crude state, it passes necessarily through the department of the refiner before it reaches that of the chief coiner; I therefore give the actual details of the refining operations upon sundry deposits of gold, amounting in the aggregate to $2,000,000.

The deposits are immediately weighed and a certificate of their gross weight issued. The fires having been lighted in the five furnaces of the deposit melting-room at four or five o'clock, A. M., all the deposits, amounting perhaps to seventy or eighty, are melted before noon; assay slips are then taken off, and the assays finished* the next morning, after which their values are calculated by the weight after melting, care being taken to include all the grains that can be procured from the flux, pots, &c., by grinding them up under a pair of small chasers, sifting, and washing. There is a clerk and his assistant and one hand wholly engaged in performing all the weighings for the treasurer, such as weighing deposits before and after melting, ingots for coinage, fine bars, and the clippings after cutting out the planchets. There are five men in the deposit melting-room, two of whom attend to two furnaces each at the same time, one to one furnace and washing grains, and the remaining two are laboring assistants. The whole deposit of $2,000,000 is melted in three or four days in the deposit-room, and assayed by from the third to the seventh day.

As soon as the first deposits are assayed, say on the third day (if expedition is necessary,) or always on the fourth, they are granulated in the proportion of one part of gold to two parts of silver. The pots contain 50 lbs. of gold and 100 lbs. of silver, equal to 1800 oz., and each melt requires about an hour. With four furnaces (attended by four melters and two aids,) there are ordinarily made thirty-two melts per day, but when hurried forty-eight melts can be made, making from one-third of a million to one-half of a million dollars per day. Two days' work, or about $650,000 worth of gold, equal in weight to one ton (avoirdupois weight,) are granulated for a single setting with acid. The granulated metal is charged into large pots, together with pure nitric acid of 39° Beaumé, between the hours of seven and nine A.M. on the sixth day, and steamed for five hours. The pots, made in Germany, are 2 feet in diameter by 2 feet in depth, set in plain wooden vats, lined with $\frac{3}{16}$-inch sheet-lead; a single coil of copper pipe passing around the bottom of the vat blows the steam directly into the water, in which the pots are set to about half their depth.

The vats are arranged in a small house in the middle of the room with a large flue connecting with the chimney-stack, so that when in action the odor of nitrous fumes is scarcely perceptible in the building. The $2,000,000 require about sixty such pots; they are stirred about once

* The mode of assaying is according to the "wet process" of Gay Lussac. This is too well known to need description here.

each hour, say altogether five times, with simple wooden paddles; the next day (seventh,) the acid solution of nitrate of silver is drawn off by a gold-syphon into wooden buckets, and transferred to the large vat, in which it is precipitated by salt (chloride of sodium,) and fresh acid added to the metals, now containing very little silver. Steaming for five hours on the seventh day completes the refining of $650,000. Early on the eighth, one pot is drawn off, washed with a little warm water, and the gold-powder transferred to a filter. Fresh granulations are put into this empty pot, and the acid of the adjoining pot baled over upon them, and thus through the series, the whole being re-charged in from two to two and a half hours. After steaming for five hours, the acid which contained but little silver from the preceding day becomes a nearly saturated solution of nitrate of silver. By this arrangement 4½ lbs. of nitric acid are consumed altogether for each pound of gold refined, and the latter is brought up to 990 a 993 m. fine,—rarely below 990. Thus every two days, 13,000 lbs. of nitric acid are used. In the course of the last year 1,000,000 lbs. of pure nitric acid, at seven cents per pound, equal to $70,000, were consumed.

The gold is washed with hot water on the filter during the eighth day, and until it is sweet, (say by 7 P.M.) The filter consists of two layers of tolerably stout coarse muslin, with thick paper between, in a tub with a false bottom, 2½ feet in diameter and 2½ feet deep, and mounted on wheels. One of the men remains, after washing hours, until 7 P.M., when the watchman of the parting-room continues washing the gold and silver until sweet, *i. e.*, until the wash-water ceases to color blue litmus paper. Early on the ninth day the wet gold is pressed with a powerful hydraulic press, and the cakes then thoroughly dried on an iron pan, at a low red heat. This process saves wastage in the melting-pot, since there is no water remaining in the pressed metal to carry off gold in its steam. The same day (ninth) the gold is usually melted with a less proportion of copper than is requisite to make standard metal, and cast into bars, which are assayed by noon on the tenth. They are then melted with the proper quantity of copper, partly on the same day, partly early on the eleventh, and assayed and delivered to the coiner the same day. On the fourteenth they are ready for delivery to the treasurer as coins.

The silver solution drawn off from the pots is precipitated in a large wooden vat of 10 feet diameter by 5 feet deep, and the chloride of silver immediately run out into large filters [$6 \times 3 \times 14$] where it is washed sweet. The filter is covered with coarse muslin, and the first turbid water thrown back; the filter, which is on wheels, is then run over to the reducing vats, and the chloride shovelled into them. There are four such vats [$7 \times 4 \times 2$] made of wood and lined with lead, 1 inch thick in the bottom. A large excess of granulated zinc is thrown on the moist chloride in the vats, without the addition of acid; the reduction is very violent, and when it slackens, oil of vitriol is added to remove the excess of zinc. The whole reduction occupies a few hours, and after a night's repose the solution of mixed sulphate and chloride of zinc is run off into the sewer.

About 2 tons of zinc per $1,000,000 of gold are employed; the silver, however, in this amount, say 10 per cent. by weight, should only take,

by equivalents, about 2400 lbs., so that nearly 2 equivalents of zinc for 1 equivalent of silver are used. This is found to be advantageous, as both time and space are greatly economized by this excess.

The day after the reduction the reduced silver is washed, and the second day it is pressed and dried by heat, the same hydraulic press as for gold being used, but with different drying-pans. The same silver is used again for making fresh granulations, but as it accumulates from the Californian gold, 10,000 or 20,000 ounces are now and then made into coin, great care being taken in this case to avoid getting gold in it when drawing off the silver solution, and in the press.

Such are the actual working details in refining a specified amount ($2,000,000) of gold, the first-third of which is delivered as coin in fourteen days after its arrival, and the third third in eighteen days.

But as there is a bullion-fund of $5,500,000 allowed by government, depositors are paid from the third to the fifth day after an arrival, *i. e.*, as soon as the gold is melted, assayed, and its value calculated. When two heavy arrivals occur in close succession, the time of refining and coining can be shortened from 14 to 10 days.

The number of men engaged in the refining department is 14 : 1 foreman, 8 for the parting process, 3 for reducing, and 2 for pressing and drying. In the gold melting-room there are 3 melters and 2 assistants. The total number of hands in the melting and refining departments is 34, including a melting and parting foreman, and 3 in the place for grinding, sifting, washing, and sweeping. This last place or sweep, embraces all pots, ashes of fires, trimmings of furnaces, ashes of all woodwork, &c.

The late law for reducing the weight of silver coin necessitated an increase of force, and 15 more were in consequence employed for this purpose. While $50,000,000 in a year have been parted with the above force, they could with the same force and apparatus refine $80,000,000 if it were required.

After many experiments upon anthracite, Professor Booth stated that he had at length fully succeeded in employing it for melting both gold and silver in the same furnaces, slightly modified, in which he had been accustomed to melt with charcoal. This change had been accompanied by great economy in the cost of material and labor, and by greater comfort to the workmen, from being less exposed to heat. The cost of charcoal (of the best quality—hard pine-knot coal) is 16 cents per bushel, delivered at the Mint ; and while the cost of this fuel for all their operations in 1852, when gold was chiefly refined and melted, was about $7000, the cost of anthracite will be from $600 to $1000. In using the anthracite, he found that a simple draft of air, without a blast, was quite sufficient to sustain combustion.

Californian gold frequently contains the alloy "iridosmine," which is not always detected by the assay. In order to remove it as far as possible without actually dissolving gold, it is allowed to subside, first in the granulating crucibles, and then in the crucibles for toughening (melting fine gold and copper). If the assayers report its presence in the toughened bars, they are again melted, and the iridosmine allowed to subside. By these three, and often four successive meltings, the gold

is separated from its troublesome companion as far as practicable. The gold thus refined, and reduced to the proper standard, [*Section* 8: "And be it further enacted, that the standard for both gold and silver coins of the United States shall hereafter be such, that of 1000 parts by weight, 900 shall be of pure metal and 100 of alloy; and the alloy of silver coins shall be of copper, and the alloy of gold coins shall be of copper and silver; provided that the silver does not exceed one-half of the whole alloy,"] is delivered over to the chief coiner in the form of bars or ingots of a certain weight, to be divided and shaped into pieces required for the currency of the country.

The *Coining* department of the establishment is of a power and efficiency sufficient to perform all the mechanical processes incidental to the issue of nearly 70,000,000 of pieces during the past year; and I was assured by Mr. Franklin Peale, the chief coiner, that it could have executed much more if it had been steadily employed, or fully supplied with material during the whole of that period. It is not necessary to go through the whole course of operations in this department, but to notice only such as possess novelty or present special characteristics.

The necessary power for working the machinery is obtained from a large steam-engine of the form usually known as the steeple-engine; it is a double vertical high-pressure engine, with cranks at right angles, the power being carried off by a caoutchouc belt, 2 feet wide, from a drum of 8 feet in diameter; the estimated power is equal to 90 horses. At times, this is all required, at others much less is sufficient, and in uncertain proportions; to meet this irregularity, and to ensure that steadiness of motion so necessary in such delicate operations, a governor and throttle-valve of a peculiar construction have been devised, which have now been in use for some time, and have produced most satisfactory results, fully effecting the purpose for which they were designed. The rolling mills, four in number, are driven by belts, at the rate of six revolutions per minute; the distances between the rollers being adjusted by double wedges, moved by a train of wheels which are connected with a dial-plate and bands, divided and numbered into hours and minutes, so as to indicate the proper thickness of the strips of metal without the use of gauges. Gold strips are heated in an iron heater by steam, and waxed with a cloth dipped in melted wax, and the silver strips are coated with tallow by means of a brush. The draw bench is used for both metals, and trial pieces are cut from every strip and their weight tested, preparatory to the cutting of the whole.

The cutting processes are very simple and efficient, consisting of a shaft moved by pulleys, and a 2½-inch belt, with a fly-wheel of small diameter but sufficient in momentum to drive the punch through the slip of metal by means of an eccentric of ⅜-inch, at the rate of 250 pieces per minute, which skilled hands can readily accomplish and continue until the slip is exhausted. The annealing during the rolling of the ingots into slips is performed in copper cases, in muffles of fire-clay and brick, heated by anthracite coal, three muffles or hearths being kept at a bright red heat by one fire-grate or furnace, and the distribution and intensity regulated by dampers. These annealing furnaces are recent in their construction and very satisfactory in operation; they are heated by anthra-

cite at the cost of about one-fourth the expense of the wood previously employed.

The whitening of planchets is performed as usual by inclosing the gold in luted boxes, and by exposing the silver in an open pan, to the heat of a simple furnace with wood fuel; the drying and sifting after the action of dilute sulphuric acid, is rapidly and effectually accomplished by a rolling screen—one portion of which consisting of a pair of closed concentric cylinders, between which high-pressure steam is admitted. The blanks, with a sufficient quantity of light wood saw-dust (linden or bass wood is the best), being introduced into the interior cylinder, a revolving motion is given to it by the engine for a certain time; the door is then opened and the blanks and saw-dust gradually find their way into the wire screen, by which they are separated, the movement being continued until the separation is complete, when the blanks are discharged at the end of the machine. An arrangement exists by which a slight inclination is given to the machine so as to direct the motion of the blanks towards the discharging end.

The milling machines are, I was informed, peculiar to this mint, and are in a great measure original, the operation being performed by a continuous rotary motion, with great rapidity and perfect efficiency, varying in rate according to the denomination of the coin, between 200 and 800 pieces per minute, and at the same time separating any pieces that are notably imperfect.

It must be understood that the operation here termed "milling," is merely for the purpose of thickening and preparing the edge, so as to give a better and more protective border to the coin, the ornament or reed, commonly known I believe in this country as "milling," being given to the piece by the reeded collar of the die in which the piece is struck.

The coining presses, 10 in number, and milling machines are worked by a high-pressure horizontal steam-engine, made from the design and under the direction of the present chief coiner, in the workshops of the establishment, in 1838.

The presses are three sizes, the largest applicable to the striking of silver dollars and double eagles:—the second to pieces of medium value:—and the smallest to the dime, half dime, and 3-cent pieces. The first is usually run at the rate of 80 per minute, the last at 104 per minute,—the average rate of the whole is 82 per minute. This rate can be increased if required.

If all the presses were employed in coinage at the usual rate, they would strike in one day (9 working hours) 439,560 pieces; and if employed upon gold, silver, and copper, in the usual manner, and on the usual denomination of coin, they would amount in value to $966,193.

During the past year, on one occasion, 8 of the presses were run 22 out of 24 consecutive hours, and coined in that time 814,000 pieces of different denominations of coin.

These presses have been made principally in the workshops of the Mint. They possess in common with the presses of Uhlhorn, in Germany, and Thouellier, in Paris, the advantage of "the progression lever," "le genou" or "toggle joint," a mechanical power admirably adapted to this

operation; but in almost every other particular they are original in arrangement, being the result of experience, beginning as far back as 1836.

In order to supply these presses, various means have been devised; among them, and not the least important, is the "shaking box," in which advantage is taken of a disposition observable in similar bodies, or bodies of similar form, to arrange themselves in similar positions. This is a box, whose bottom is constructed with parallel grooves adapted to the size of the blanks or planchets to be arranged. A quantity of them is thrown indiscriminately into the box, which is then quickly shaken in the direction of the grooves, the pieces immediately lay themselves side by side, in parallel rows, from which they can easily be lifted in roleaux as required to be passed to the feeding tubes of the mills or presses.

It is very evident to all visiting the establishment that such a large number of pieces could not be coined and manipulated by such a limited number of hands without the aid of some labor-facilitating arrangements, one of the most worthy of remark of which is, the method of counting the pieces coined—if counting it can be called, for in principle it is a measuring machine. The arrangement of this counting frame, or tray, may be understood from the following sketch of its construction:

A board or tray of such dimensions as may be required, is divided by a given number of parallel metallic plates dissected into its plane and slightly elevated above it, the edges of which rise no higher than the thickness of the coin for which it is intended. The board is of such a length as will admit of a few more than the required number of pieces to be laid longitudinally in the rows, and is divided across and at right angles with the rows, and hinged at a point opposite to a given number. One of those employed by this department, counted 1000 pieces, that is to say, it had 25 parallel grooves or rows sufficently long to receive 45 pieces. Now, having thrown on this board a large excess of pieces, it is agitated by shaking until all the grooves are filled, and then inclined forwards until all the surplus pieces have slid off, one layer only being retained by the metallic ledge; the hinged division is then suffered to fall, which at once throws off all but the 45 pieces in the length of each row. This operation, somewhat difficult and tedious to describe, is performed in a few seconds, and results in retaining on the board 1000 pieces, each piece exposed to inspection, and the whole accurately counted without the wearisome attention—so likely to result in error—required under usual circumstances.

The very large number of pieces coined during the last year has been counted exclusively by two female manipulators, assisted by a man who had the duty of weighing them in addition as a testing check. The same amount of labor by ordinary means could not have been performed with fewer than thirty or forty hands, to say nothing of inferior accuracy. This machine was originally arranged and patented by the late R. Tyler, coiner of the New Orleans Branch Mint, but materially improved in its application and construction by Mr. Franklin Peale.

The balances of the Mint of the United States have received the attention necessary to an instrument of such importance in mint operations. They have been arranged and made generally in the workshops of the establishment, and operate entirely to the satisfaction of the department.

It is not necessary to enter into details of their construction, as a full and minute description is given in the *Journal of the Franklin Institute* for July, 1847. I, perhaps, ought to mention that since that appeared, some slight improvements have been made by inclosing all but the stirrups and pans in glass, by these means excluding dust and protecting them from the influence of air currents.

In concluding this brief sketch of the practical working of the two most important departments of the United States Mint, I cannot omit a reference to the very excellent remarks of the chief coiner on the employment of females in some of the operations in his department. This, he informed me, had generally excited the surprise of, and been commented upon, by foreigners, who had visited the Mint. His experience, however, had led him to believe, that in places of trust, where no great physical exertion was called for, but where accuracy and strict integrity were of first importance, the moral perceptions of the female, generally stronger and of a higher standard than in the man, would qualify her as his substitute, and thus, while opening a new field of labor for the occupation of females, would strengthen their claims to it by the superior accuracy and economy of their work.

For the Journal of the Franklin Institute.

The Mammoth Steamer of Great Britain.

The following comprise most of the essential elements of this monster iron vessel, building by Messrs. Scott Russell & Co., for the Eastern Steam Navigation Company:

Length,	675 feet.
Beam,	83 "
Depth of hold,	60 "
Draft of water at load line,	30 "

This vessel is to be propelled by four steam engines, two of them connected with side water wheels, and two with a screw propeller.

The water wheel engines are to be of 1000 horses; oscillating cylinders, 74 inches diameter, by 14 feet stroke of piston.

The screw engines are to be of 1500 horses, 84 inch cylinder, and are to be made by Messrs. Bolton & Watt.

The boilers will have 100 furnaces.

The hull is divided into water-tight compartments of 60 feet. The weight of plates will be 10,000 tons, and the number of rivets 3,000,000. The plates at bottom are to be one inch thick, and three-quarters at sides and top.

The frame is to be plated within as well as outside the ribs, up to the water line.

Water wheels are to be 60 feet in diameter.

Vessel to accommodate 600 first class and 2000 second and third class passengers, and to carry 12,000 tons of coal. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steamboat Cuba.

Hull built by Samuel Sneden, Greenpoint, L. I.; Machinery by Pease & Murphy, New York; Intended service, Mobile to New Orleans.

HULL.—

Length on deck, from fore part of stem to after part of stern post, above the spar deck,	250 feet.
Breadth of beam at midship section,	32 " 8 inches.
Depth of hold,	9 "
Draft of water at load line,	6 " 6 "
" " below pressure and revolutions,	6 "
Tonnage, custom-house,	800.
Masts and rig,	foresail and jib.

ENGINE—Vertical beam.

Diameter of cylinder,	56 inches.
Length of stroke,	10 feet.
Maximum pressure of steam in pounds,	80.
Cut off,	⅞.
Maximum revolutions per minute,	18.

BOILER—One—Flued.

Length of boiler,	35 feet.
Breadth "	13 " 9 inches.
Height " exclusive of steam chimney,	13 " 3 "
Number of furnaces,	3.
Breadth of "	3 " 8½ "
Length of grate bars,	7 " 8 "
Number of upper flues,	6.
Internal diameter of flues,	19 and 21 ins.
Heating surface, (fire and flues,)	1700 sq. feet.
Diameter of smoke pipes,	5 feet.
Height "	36 "
Description of fuel,	wood.
Combustion,	Natural draft.

PADDLE WHEELS.—

Diameter,	30 feet.
Length of blades,	8 "
Depth "	2 " 2 inches.
Number "	28.

Remarks.—Floor timbers at throat, *molded*, 15 inches;—*sided*, 5 inches;—distance of frames *apart at centres*, 24 inches. Frame strapped with diagonal and double laid iron straps 4 by ½ inch. C. H. H.

For the Journal of the Franklin Institute.

Particulars of the Steam Tug Leviathan.

The following particulars possess more than ordinary interest, inasmuch as they contain the exact dimensions and reliable elements of performance of the fastest sea steamer in American waters; and if this statement should appear unreasonable to any one, he is referred to the cross area of a single run of her water wheel blades compared to her midship section, which bears the relation of 39 to 176, and this, too, with a velocity given to their periphery of 23 statute miles per hour; the deduction to be made from this for slip of wheel, is left to your profes-

sional readers; for, as I have no means of arriving at it by observation, they might be unwilling to take my estimate of it; of one fact, however, I can furnish them, and that is, that this vessel being employed daily in the towing of vessels in and out of the harbor of New York, has had the opportunity, upon many occasions, of testing her speed with all the steamers that trade to that port; and still, up to this time, she has never found a troublesome competitor.

Hull built by Eckford Webb; machinery by Allaire Works, N. York. Intended Service, towing.

HULL.—

Length on deck, from fore part of stem to after part of stern post above the spar deck,		179 feet.
Breadth of beam at midship section, molded,		29 " 3 inches.
Depth of hold to spar deck,		11 " 6 "
Length of engine and boiler space,		71 "
Tonnage, Custom House,	500	

ENGINE.—Vertical beam.

Diameter of cylinder,		60 inches.
Length of stroke,		10 feet.
Maximum pressure of steam in pounds,	30	
" revolutions per minute,	22	
Point of cutting off,	½	
Draft of water at above pressure — revolutions,		8 feet.
Area of immersed midship section at this draft,		176 "
Diameter of water wheel,		29 " 4 inches.
Length of blades,		8 " 4 "
Depth of blades,		2 " 4 "
Number of blades,	21	

BOILERS.—Two.—Return flued.

Length "		28 feet.
Breadth "		10 "
Height " exclusive of steam chimney,		9 " 10½ ins.
Number of furnaces,	4	
Width "		4 " 4 "
Length of grate bars,		7 " 7½ "
Number of flues,	15	
Internal diameter of flues, lower tier, 8 of		12¼ "
" " " " " 2 of		18 "
" " " upper return, 5 of		16 "
Length of flues, lower tier,		15 feet 8½ inches.
" " upper tier,		21 " 9 "
Diameter of smoke pipe,		5 " 5 "
Height " (above grate bars,)		64 " 5 "
Heating surface, fire and flues,	2927	
Combustion,	Natural draft.	
Capacity of coal bunkers, in tons of coal.	30	
Consumption of coal per hour,	2240 lbs.	
Draft of water at load line,		8 feet.
Frame of white oak and chestnut.		
Floors molded,		13 inches.
Floors sided,		6 "
Distance of frames apart at centres,		2 feet 4 "
Masts and rig,	None.	
Description of coal,	Anthracite.	

Remarks.—Coppered.

C. H. H.

Method of Representing Objects by Printing Directly from them.

By Felix Abate, of Naples.*

This invention constitutes a new art, by means of which natural and artificial objects can be represented and imitated by printing directly from the objects themselves upon any suitable substance. The specimens submitted to the inspection of the Society at its last meeting, are imitations of veneering wood, some simple, and some ornamented with inlaid work, made upon wood, calico, and paper.

Before entering into the details of this invention, I may perhaps be allowed to state, in order to prevent mistakes, that it is essentially different from the well-known invention under the name of *Phytoglyphy*, or Nature-printing, patented in England by Messrs. Bradbury & Evans, and practised at the Imperial Printing Office at Vienna, and which consists in taking impressions in lead or other metals, or gutta percha, from natural objects, making electro-plates from such impressions, and then printing with these plates in the usual way. The principle of my invention dates from an epoch anterior to the Great Exhibition of 1851, as I exhibited on that occasion the first specimens of a particular application of it, called *Metallography*. For this branch of the art, I was rewarded with the prize medal. An idea of this art will be obtained from the following notice of the principles and processes upon which it rests:

The art of *metallography* consists in printing from engraved wood blocks upon *metallic surfaces*, so as to produce imitations of figures and ornaments inlaid in wood. This effect is obtained by using, as a printing menstruum to wet the block with, solutions of such metallic or earthy salts as are decomposed when brought into contact with certain metals, and produce, through an electro-chemical action, an adhesive precipitate of a colored metallic oxide, or any other chemical change upon the metal. Such are the salts of copper, antimony, &c., upon zinc, tin, silver, &c.; the hydrosulphuret of ammonia upon copper and brass.

There are two principles at work in this branch of the art—the one is the chemical action just referred to; the other, which is the foundation and the keystone of the invention in its most general sense, rests in the porousness of the printing object, which causes the absorption of the wetting fluid, and yields it, under the action of pressure, in quantity for each point proportionate to the capacity of the pores; so that if any chemical change is wrought upon the impression, to produce a coloring of it, this coloring, by its different shades, makes a true representation of the printing object.

The application of the invention to printing upon vegetable substances instead of metallic surfaces, required the introduction into the process of some new principle to produce that chemical change which, in metallography, is spontaneous. I devised, for that purpose, two principles, which, by different means, lead to the same results. One of these principles I borrowed from the art of dying. It consists in the peculiar actions that the salts, acids, and alkalies have upon each other, and upon vegetable coloring matters. It is upon these actions the processes of

* From the London Mechanics' Magazine, July, 1854.

mordant and discharge printing on textile manufactures rest. The surface of the printing object is slightly wetted with the acting fluid, which is then well wiped off from the surface; the impression is then taken, which, by combining with a previous or a subsequent dyeing of the printed surface, instantaneously appears. The other principle I found in heat, that is, in the coloring action that this most powerful agent of Nature has upon vegetable substances when acted on by acids, which coloring, I believe, is the effect of an accelerated carbonization of the surfaces of these substances produced by the acid. I think I may properly call this art THERMOGRAPHY, or the art of printing by heat.

From the following description of the process, it will be remarked—perhaps with some degree of surprise—the excessive sensitiveness of vegetable substances under the joint action of acids and heat, so that an infinitesimal dose of the former, and an instantaneous application of the latter, are sufficient to produce the most striking effects. The process is as follows:

Suppose a sheet of veneering-wood be the object from which impressions are to be taken; I expose the wood for a few minutes to the cold evaporation of hydrochloric or sulphuric acid, or I slightly wet it with either of these acids diluted, and then well wipe the acid off from the surface. Afterwards it is laid upon a piece of calico or paper, or common wood, and by a stroke of the press an impression is taken, which is, of course, quite invisible; but by exposing this impression, immediately after, to the action of a strong heat, a most perfect and beautiful representation of the printing wood instantaneously appears. In the same way, with the same plate of wood, without any other acid preparation, a number of impressions, about twenty or more, are taken; then, as the acid begins to be exhausted and the impressions faint, the acidification of the plate must be repeated as above, and so on progressively, as the wood is not in the least injured by the working of the process for any number of impressions. All these impressions show a general wood-like tint, most natural for the light-colored woods, such as oak, walnut, maple, &c.; but for other woods that have a peculiar color, such as mahogany, rosewood, &c., the impression must be taken, if a true imitation be required, on a stuff dyed of the light color of the wood.

It must be here remarked, that the impressions, as above made, show an inversion of tints in reference to the original wood, so that the light are dark, and *vice versa*, which, however, does not interfere with the effect. The reason of it is, that all the varieties of tints which appear in the same wood are the effect of the varying closeness of its fibres in its different parts, so that where the fibres are close, the color is dark, and light where they are loose; but in the above process, as the absorption of the acid is greater in proportion to the looseness of its fibres, the effect must necessarily be the reverse of the above. However, when I wish to produce the true effect of the printing wood, I alter the process as follows:—I wet the surface upon which the impression is to be taken with dilute acid, and then I print with the veneering wood previously wetted with diluted liquid ammonia; it is evident that in this case the alkali neutralizing the acid, the effect resulting from the subsequent action of heat will be a true representation of the printing surface.

Such is thermography, or the art of printing by means of heat. Now it is nothing but natural to anticipate in regard to this art, as well as to the other above-described process for printing directly from objects, that they will afford most important services to the natural, botanical, mineralogical, and anatomical sciences; as it is by their means that the internal structure of bodies is unveiled to the eyes of the philosopher, and the wonders of nature in its inexhaustible varieties are indefinitely multiplied, to be subjected to the investigation and to serve the gratification of mankind.

But the new art will prove not less useful to the decorative arts, particularly in its application to produce imitation of rare and costly woods, as well as of works of art, mosaic and inlaid work applicable for paper-hangings, or for furniture in the place of veneering, these imitations being produced at an exceedingly low cost, while they rival in perfection the original objects, enabling those whose means are limited to obtain decorations at once cheap and in good taste.—*Journ. Society of Arts.*

---

*The Navigation of Iron Ships.**

In his paper, read before the British Association on this subject, Dr. Scoresby observed, that since the first promulgation of his views at the British Association in Oxford, in 1847, he had to contend with either the *denial* or *non-reception* of them from the principal body of scientific men engaged in the consideration of compass adjustment and compass action in iron ships. But it was now most gratifying to find, from the paper of Mr. Archibald Smith, a gentleman eminent as a mathematician, and having all the records of Her Majesty's ships, as to compasses, at command, that every essential principle for which he contended, as to the principles which affect the development, destruction, and changes in the magnetism of iron ships, is admitted and supported. These principles, so supported by Mr. Smith, might be thus enumerated:—1. That the magnetism of iron ships in its action on the compass, may be represented by a vertical and a horizontal iron or magnetic bar swinging round a compass; a mode of illustration which he, Mr. Smith, had adopted some years ago, and described in lectures, as well as in his publication of 1851. 2. That changes in the magnetic distribution and compass action in iron ships, which he predicted, do take place. 3. That the changes take place in a ship's magnetism by change of magnetic latitude, a fact inferred from the Admiralty observations which his (Dr. Scoresby's) experiments satisfactorily elucidated as a necessary consequence of the resistance in iron to change in regard to the denomination of *retentive* magnetism. 4. That there are influences in a ship derived from the varieties of form and position (relatively to the compass) of particular masses of iron, which may act as *natural correctives*. 5. That the plan of correcting the duration of iron ships by *fixed magnets* (unless in places or limited voyages) is unsafe, and in going to southern regions aggravates the error. 6. That the twisting of the iron materials of a ship will tend, especially in ships

* From the London Mechanics' Magazine, October, 1854.

recently launched, to alter the magnetic action on the compass. 7. That it requires time to effect the changes in a ship's magnetic distribution, which ultimately may, in regions distant from the place of building, be effected. And the whole of the results plainly go, he believed, to the establishment of a proposition, of the accuracy of which he has long endeavored to convince those interested in the navigation of iron ships, that the magnetism of such ships is, in all its qualities, changeable; the most enduring, or apparently fixed, which he has denominated *retentive magnetism*, being of a description changeable under severe straining and mechanical violence. No large changes may be expected under the following circumstances:—1. In iron ships long in use, and ordinarily pursuing the same voyage, because extreme distribution gets shaken down, as it were, in a medium or average state. 2. Great changes do not take place in the retentive magnetism (by far the greater portion) in latitudes not farther south than the Mediterranean, because, 3, in ships trading in the channels, or east and west to America, the liability to new or unexpected changes greatly diminishes. In such cases, an intelligent captain, observing the changes, duration, alteration, and allowances, may generally run with great confidence. Experience will establish the effect of circumstances in this case. Suggestions:—1. A standard-azimuth compass to be placed on a high pedestal, where (on the Admiralty plan) a position of small duration may be found. 2. A compass at masthead he believed best of all for reference, by which the great body of error will be demonstrated. 3. The wheel-compass required for ships engaged in the home trade, or traversing mainly parallels of latitude not southward of the Mediterranean, if adjusted with magnets and pieces of iron, may not be then unsafe, where reference may always be had to the standard for verification. 4. No standard compass in great distances. 5. Care in selection of compasses, to have ample directive force. His improvements had trebled the directive force, weight for weight, of the compasses used in the Navy up to 1839 or 1840. 6. Captains must be made to take observations for verifying their compasses by azimuth compasses, stars, position of land—a subject of examination. 7. Captains should have a special knowledge for the charge of iron ships, for here, in addition to the ordinary dangers of navigation, is a new source of error and misguidance, as to which, it is most important, he should never be thrown off his guard. 8. Rules of caution.

---

*On some Peculiarities of the Magnetic Field.**

Professor Tyndall accompanied the reading of this paper with experiments adopted for the purpose of better elucidating the subject. He said, a piece of soft iron suspended between the flat poles of an electro-magnet set its largest dimensions from pole, the residual magnetism of the cores being sufficient to produce the effect. This is the normal deportment of magnetic bodies, but it is by no means universal. By mechanical agency, by pressure for example, the structure of a magnetic body can be so modified that its shortest horizontal dimension sets from pole. Pro-

* From the London Mechanics' Magazine, October, 1854.

fessor Tyndall exhibited actions of the kind where the body operated on was compressed magnetic dust. In such a body two opposing tendencies were at work,—the tendency due to length, which sought to set the length axial, and the tendency due to structure, which sought to set the line perpendicular to the length axial. Between the flat poles the latter tendency was predominant, but between pointed poles this was not the case; here the attraction of the ends of the magnetic mass constituted a mechanical couple of sufficient strength to overcome the directive tendency which was due to structure, and to draw the mass into the axial line. But in raising or lowering the body operated on out of the sphere of this local attraction, by bringing it into a position where the distribution of the magnetic field resembled that existing between the flat poles, the body forsook the axial position and turned into the equatorial. The complementary phenomena were exhibited by bismuth. A normal bar of this substance sets its length at right angles to the line from the poles; but Professor Tyndall exhibited a bar of this substance, which set between the flat poles exactly as a magnetic body. Such a bar, however, between the points set equatorial. On raising it or lowering it, however, it forsook the equatorial position and set axial. In this case the local repulsion of the ends between the points caused the bar to set equatorial, the influence of length thus predominating over the influence of structure; but removed from the sphere of this local action, the directive tendency of the mass triumphed and caused the bar to set axial. The bar in this case was cut with its length at right angles to the planes of most eminent cleavage of the bismuth. It is a proved fact, that these planes, while the influence of form is annulled, always set at right angles to the line piercing the poles, and hence where they are transverse to the length, the bar will set axial. These phenomena were examined in a great number of cases; bars were taken from substances possessing a directive tendency, and it was so arranged that the directive tendency due to structure was always opposed to the influence of length; between the points the former tendency succumbed to the latter, while between the flat poles, or above and below the points, the former was triumphant. It is amusing to observe the strife of these two tendencies in substances possessing a strong directive action. A plate of crystallized carbonate of iron, when properly suspended, will wrench itself spasmodically from one position into the other, and find rest nowhere. The simple law which governs all these actions is, that if the body, cut as above, be diamagnetic, its length sets equatorial between the points, but above and below them axial. If the body be magnetic it sets axial between the points above and below equatorial. Hence, the rotation of a magnetic body, on being removed from between the points, is always from axial to equatorial; while the corresponding rotation of a diamagnetic body is always from the equatorial to the axial. The deportment of wood in the magnetic field was next described. Nearly sixty specimens examined by Professor Tyndall were all diamagnetic; each of them was repelled by the poles of the magnet; cubes of each when suspended with the fibre horizontal set between the excited poles, the fibre perpendicular to the line which unites the poles. Thinking that wood, on account of its structure, would exhibit those directive phenomena which had been demonstrated in the

case of the bodies mentioned at the commencement, bars were taken from nearly forty kinds of wood, the fibre being at right angles to the length of the bar; in the centre of the space, between two flat poles, all those bars set their lengths from pole to pole. But Professor Tyndall afterwards observed the remarkable fact, that homogeneous diamagnetic bodies did the same. Bars of sulphur, of salt of hartshorn, of wax, and other diamagnetic substances, when suspended in the centre of the space between two flat poles, set their lengths from pole to pole. Now, as diamagnetic bodies always take up the position of weakest force, it was proved by these experiments, and corroborated by others not cited here, that the true force of the centres of two flat poles, contrary to the general opinion hitherto received, was the line of minimum force.

The Rev. Dr. Scoresby stated that, by subjecting to force ordinary magnets of hardened steel, as by suddenly bending them, or striking them in particular modes, they may have their poles reversed or be deprived of their magnetism, or hardened non-magnetic steel may be instantly rendered magnetic; and he considered that these facts, which he had long since made public, should be kept before the mind in such investigations as the very original and interesting facts just brought under the notice of the Section.—Professor Faraday, after very briefly, yet lucidly, explaining to the Section the leading distinctions between paramagnetic and diamagnetic bodies, and their behavior in the magnetic field, said, that it was conceded on all hands that the explanation was erroneous which Plücker had given of the phenomena which he first discovered connected with the branch of research to which Professor Tyndall had just been directing their attention, and which he was so ably hunting down. But when he said the original explanation of Plücker was erroneous, he did not mean that as the slightest disparagement to that philosopher. It was well understood by all who had any pretensions to scientific knowledge since the days of Bacon, that it was through the mist of error that the most important discoveries had to be made, and that in pursuing any research it was much better in the first stages of the inquiry to have erroneous views, than to be without any views that would tend to connect the scattered facts. For his part, he was not ashamed to own that he was a learner, and that in almost every instance it was through the clouds of error that he arrived at the conclusions which satisfied him most. And as his mathematical skill and acquirements were by no means such as to entitle him to despise instruction, he should feel particularly grateful to his mathematical friends present, Dr. Whewell and others, if they would explain to him and to the Section the law of distribution of the magnetic force in the magnetic field, if it was known. Dr. Whewell explained how the force would be distributed upon the old theory of magnetic lines; but he said he was aware, and he believed it was now generally admitted, that this theory must be greatly modified, if not given entirely up. But as he saw Professor W. Thomson in the Section, who had paid particular attention to the development of the mathematical theory of magnetical and electrical forces, he trusted that that gentleman would favor the Section with his views.—In answer to Professor Faraday's question, as to the mathematical conditions under which a uniform field of magnetic force may be produced, Professor W.

Thomson remarked, that the mathematical theory of the distribution of force both afforded a remarkably simple and definite general answer, and pointed out the most convenient practical means of fulfilling these conditions, either approximately or rigorously. For, in the first place, it is strictly demonstrable that if the force be rigorously uniform in some locality, in the neighborhood of any kind of magnet or electro-magnet, through even one one-thousandth of a cubic inch, in fact, through any finite bulk, however small, it cannot but be vigorously uniform through every portion of space to which it is possible to go from that locality without passing through the substance of the magnet. Hence, although between flat poles, such as Mr. Faraday first introduced for obtaining uniformity of force, we have in reality a most excellent practical approximation to a uniform distribution of very intense magnetic force, through a space of several cubic inches, in a locality not only visible, but in every way convenient for experimental purposes; yet it is absolutely impossible that the force can be rigorously uniform through the smallest finite bulk of the magnetic field in any such arrangement, or, generally, in any locality external to a magnet. If an experimenter wants a rigorously uniform field of force, he can only have it in the interior of his magnet; and he must be contented not to see the action he experiments on at the time it is being produced, unless he will follow the example of Professor Faraday, who 'went into a hollow cubical conductor of electricity, and lived in it,' and so was enabled to observe some most interesting and important fundamental properties of electrical force. It would be easy to make a hollow electro-magnet, in the interior of which the experimenter could observe with the minutest accuracy the bearings of all kinds and shapes of bodies in a vigorously uniform field of force. All that is necessary to make such a conductor is to take a hollow *papier-maché* globe, say six feet in diameter, and roll a galvanic wire over its surface in a succession of close parallel circles, having their planes at equal distances from one another. A hollow non-magnetic body, of any shape, cubical for instance, may have a rigorously uniform distribution of magnetic force produced in its interior by a suitable distribution of galvanic wire over its surface, determinable, according to the form of this surface, by the mathematical theory from which these results are stated. But it would be difficult, perhaps practically impossible, to get a sufficient intensity for exhibiting the forces experienced by diamagnetic or weakly paramagnetic bodies in a uniform field of such extent that the operator could himself enter it; and experimenters must be contented either with approximations to uniformity, such as in the arrangement with flat poles, so successfully used by Professor Tyndall in the beautiful experiments which he had exhibited to the Section, or they must arrange to test effects in the interior of hollow electro-magnets without seeing them at the time they are taking place. Interesting questions, which the mathematical theory answers decisively, had also been asked regarding the minimum condition of the central line in a field between opposed flat poles, of two cylindrical soft-iron bar magnets, and the effects of rounding off the edges of these poles. It appears that, if we consider the intensity of the force in a plane perpendicular to the magnetic axis through the centre of the field, we find it increasing from the central point to a certain circle of

maximum intensity, beyond which it diminishes gradually and falls to nothing at an infinite distance. If the edges of the cylinders be rounded off, the circle of maximum intensity contracts, its centre always being a point of minimum intensity, until a certain degree of convexity of the poles is attained, when the circle of maximum intensity becomes contracted to a point—the central point of the field—which will then be a point of maximum intensity (the central minimum being eliminated,) and will continue a maximum, as regards all points in the plane through it, perpendicular to the axis, for any less flat or more prominent or pointed forms of poles. No form of rounded poles, by doing away with maximum or minimum points, can possibly give a uniform distribution of intensity through ever so small a finite bulk of the field. *Proc. Brit. Association.*

---

*M. Picault's Mode of Making Razors.**

He first prepares plates of cast steel, laminated to the thickness which the blades are to have, and having two opposite sides forged to a coarse edge. These plates are placed under a shears, which at one cut produces a blade. Upon these blades M. Picault stamps his mark, and by the aid of a cutting hammer he impresses a number of striated or grooved lines upon the two surfaces of the blade where it is to be fitted into the back. The back itself is formed of soft cast iron, planed and polished so as to retain none of the roughness of the casting. A groove is formed by a simple mechanical process in one of the edges, and into this is fitted the blade previously prepared. The blade and back thus joined are placed in a swage or stamp having the form of the back, and subjected to a considerable pressure by means of a lever, the effect of which is to fix the blade in the groove, where it is held tightly by means of the grooves cut in the blade as already mentioned, and into which the soft cast iron is, as it were, squeezed. There only remains the operation of grinding to complete the razor, and this is done exactly in the same way as with razors formed in one piece.

This system of manufacture appears to offer the following advantages: 1st, As to economy, in the reduction by nearly one-half of the weight of steel employed; in the fuel and labor at the forge, which become in this method insignificant; in the absence of any operations of filing down, &c., inasmuch as each blade comes from the shears fully formed; and in the rarity of failure in the operation of tempering, owing to the almost uniform thickness of the blades, which allows them to be heated to the exact point necessary for a good temper, and to cool more equally in the water. 2d, As to quality in the steel employed; in the simplicity of the forging, which is confined to the closing up of the pores of the steel upon the cutting edge of the blade, and does not necessitate the subsequent evils of cutting away the hardened surface which thick blades require; and in the fact, that in the operation of tempering, the blade being of an almost uniform thickness, the cutting edge is not subject to be burnt as in the ordinary process. The idea of applying artificial backs to razors is not new, but hitherto the methods proposed to effect it have been un-

* From the London Artizan, August, 1851.

successful, whilst M. Picault has completely resolved the problem. The only objection which can apparently be raised against his system of manufacture is, that the joining of the back and the blade may retain humidity, and rust after some time. This objection would, however, apply to all razors with artificial backs, and may be obviated by a little care in using them.—*Bulletin de la Société d'Encouragement, September*, 1853, p. 499.

---

*On the Deviation of the Magnetic Needle Peculiar to Liverpool.**

This paper was read by Sir John Ross, the celebrated Arctic explorer. He said:—"Ever since the year 1799, when my attention was first directed to the deviation of the magnetic needle, I have lost no opportunity of making observations in many parts of the globe, on the interesting phenomena appertaining to that influence—a statement of which has been published by me in the narrative of my first two voyages of discovery to the Arctic regions. Since which my attention was called to the frequent losses of ships consequent on the fallacious system adopted by the Admiralty, called 'adjusting the compass,' at Gravesend and other places; and after the loss of the *Birkenhead*, I felt it my duty to publish a pamphlet, which, although dedicated by permission to the First Lord of the Admiralty, did not at once obtain their Lordships' approbation, inasmuch as it exposed the absurdity of the system then in practice under the superintendence of a naval officer attached to the Admiralty. But I maintained the truth of my statement; and, after some correspondence on the subject, my assertions were found to be correct, and, consequently, the office of Superintendent of Compasses was abolished, and circulars issued by the Admiralty, not only ordering a monthly examination of the deviation, but that such observation should be instituted at every change of the ship's position, and on every circumstance which was known or supposed to affect the ship's deviation, or local attraction, which is now admitted to be of infinite service. But my attention has for some time been called to the fact of ships sailing from the port of Liverpool, after having been swung in the Mersey, to obtain the amount of deviations, or, as it is called, *to have their compasses adjusted*, that immediately on their proceeding on their voyage, it was found that the deviation observed in the Mersey was incorrect, and there have been lamentable instances of shipwreck in consequence. It has occurred to me that this untoward circumstance is very easily explained. The fact is, that the Mersey is not a locality eligible for ascertaining the true deviation of the magnetic needle, the ships being in a position between establishments in which large masses of iron are deposited, which must have an influence on the magnetic needle during the evolution of swinging the ship, while the embarkation of passengers with their luggage, or anything else subsequent to that process, cannot but have the effect of producing a false and dangerous result to the observations. But this evil is not without an effectual remedy, which is within the power of every captain of a ship after he has left the port of Liverpool, and which will be found in the following pro-

* From the London Mechanics' Magazine, October, 1854.

posals. It is proposed that the present method of swinging the ship in the Mersey shall be continued; and, in order to obtain a verification or a correction of results observed at that time, it is proposed to place on the sand hills of Rockland (near the Rock Lighthouse,) two posts or beacons, true north and south of each other, in the positions best seen near the red buoy of the Rock Channel, when the ships passing will be steering about true west, or west-north-west, by compass. When these two objects can be brought into one—that is, due north of each (both being south of the ship,) either a verification of the deviation that was observed in the Mersey, or the amount of difference to be taken into consideration or account on that particular point of the compass, will be shown, from which a calculation may be made in approximation of the other points; and if, further on, two other posts were erected on the magnetic meridian, the ships, on passing them, when in one with each other, could observe the exact amount of the deviation, either in the increase or the diminution of the variation on the course of the ship, keeping in mind that it will be on the south point of the compass that the observations will be made. Posts placed due south of Lizard Lighthouse would be useful, and also on the magnetic meridian. But all posts or beacons denoting the true north or south bearings, and those further off denoting the magnetic meridian, should be painted of different colors. The former—that is, the true or nearest—should be red, while the latter, showing the magnetic meridian, should be chequered. Great Ormshead and Holyhead should have beacons placed on them which would be observable to ships both outward and homeward bound. *Proceed. Brit. Association.*

---

*On the Means of Realizing the Advantages of the Air-Engine.**

This paper was read by Mr. W. J. Macquorn Rankine, C. E. The paper consisted of four Sections. In the first were explained the two fundamental laws of the mechanical action of heat, and their application to determine the efficiency of theoretically perfect engines, working between given limits of temperature; and it was shown that, as the efficiency increases with the distance between those limits; and, as it is easy to employ air with safety at temperatures far exceeding that at which the pressure of steam would cease to be safe and manageable, the maximum theoretical efficiency of air-engines, consistent with safety, is much higher than that of steam engines. For example, at the temperature of 650° Fahr., at which the air-engine has been successfully worked, the pressure of steam is 2100 lbs. on the square inch, while that of the air is optional, being regulated by the density at which the air is employed.

In the second section the various causes of waste of heat and power in steam engines were classified, and the actual efficiency of steam engines compared with their maximum theoretical efficiency, and also with the maximum actual efficiency which may reasonably be supposed to be attainable in the steam engine, by means of any probable mechanical improvements.

* From the London Mechanics' Magazine, October, 1854.

The following are estimates of the consumption of bituminous coal, of a specified quality, per horse power per hour:

1. For a theoretically perfect engine working between such limits as are usual in steam engines, ... 1·86 lbs.
2. For a double acting steam engine improved to the utmost probable extent, ... 2·50 "
3. For a well constructed and properly worked ordinary double acting steam engine, on an average, ... 4·00 "

In the third Section, the causes of waste of heat and power, in air-engines, were classified in a manner analogous to that applied to steam engines; and the actual efficiencies of those previous air-engines, as to which satisfactory experimental data have been obtained, namely, Stirling's engine, and Ericsson's engine of 1852, were compared with the efficiencies of theoretically perfect engine working between the same limits of temperature, the results being as follows, so far as they relate to the consumption of coal of the specified quality per horse power per hour:—

	Actual Consumption.	Consumption of a theoretically perfect Engine.
	lbs.	lbs.
Stirling's Engine, . .	2·20	0·73
Ericsson's Engine of 1852, .	2·80	0·82

It is thus proved that an air-engine has actually been made to work successfully and to realize an economy of fuel considerably superior to that of ordinary steam engines; and, in fact, surpassing the utmost limit to which it is probable that the economy of double-acting steam engines can ever be brought.

Stirling's engine, as finally improved, was compact in its dimensions, easily worked, not liable to get out of order, and consumed less oil, and required fewer repairs than any steam engine; still the advantages shown by that engine over steam engines, were not so great as to induce practical men to overcome their natural repugnance to exchange a long-tried method for a new one. Another circumstance caused Stirling's and Ericsson's engines to meet with neglect from scientific men: namely, that both were by some persons represented as instances of *power created out of nothing*, the popular delusion commonly called '*the perpetual motion.*' It is shown, that Stirling's air-engine, as compared with a theoretically perfect air-engine, wasted two-thirds of its fuel; and Ericsson's somewhat more.

Two obvious and powerful causes of that waste of fuel were traced: 1. Deficiency in extent of heating surface. 2. The communication of heat from the furnace to the working-air at those periods of the stroke when it is not performing work.

The necessary conclusion is, that the more completely we remove those two causes of waste of fuel, the more nearly shall we approximate to the theoretical extent of the economy of the air-engine, an extent far exceeding that to which the economy of the steam engine is restricted;

and the more fully, in short, shall we accomplish that which has hitherto been very imperfectly done *to realize the advantages of the air-engine.*

The fourth section described the improved air-engine of Messrs. James Robert Napier, and W. J. Macquorn Rankine. In this engine the heating surface is increased to any required extent by means of tubes employed in a peculiar manner. The waste of heat by its communication to the air at improper periods of the stroke, is prevented by a sort of plunger, or combination of plungers, called the *heat-screen*, which prevents any access of the air to the heating surface, except when it is in the act of expanding, and so performing work. The engine may be made of the same size with a steam engine of the same power, or smaller, according to the degree of condensation at which the air is employed. The air-receivers of an experimental engine, with their various fittings, were completed some time since, without practical difficulty, notwithstanding the novelty of their construction; but the erection of the engine has been retarded by delay in the execution of the cylinder, fly-wheel, shaft, and other parts, which are similar to those of a steam engine.

Independently of the amount and value of the saving of fuel, which will result from the introduction of the air-engine, it possesses the important and incontestible advantage, that even should an air receiver burst (which is very unlikely) the explosion would not be felt beyond the limits of the engine itself; and hot air does not scald. *Proceed. Brit. Association.*

---

*Machine for Washing Coal.**

The great advantage of purifying coals for most manufacturing purposes, and of utilising the inferior portions of coal-seams, is now strongly felt, if we may judge by the number of machines which have been proposed to effect the removal of the impurities. This machine is simple in the extreme. It consists of a large circular cistern cooped in the ordinary way, in which a wooden framework or agitator is made to revolve by means of an upright shaft driven by suitable gearing. The bottom is dished, and in its centre is a hole, to which a sort of cast iron conical pocket is fitted, the lower end of which is closed by a valve opening downwards into a canal with a bottom of wire gauze. Immediately above the bottom three pipes enter at equal distances from one another for the purpose of supplying a constant flow of water. A little above the level of these, at one side, is a rectangular opening provided with a valve, which opens upon another canal with a wire gauze bottom. The cistern is kept about three-quarters full of water; and the small coal, carried up by a chain lift or other mechanism, falls by means of a hopper into the water. The motion of the agitator causes the fragments to describe curves of more or less length, and this allows time for them to arrange themselves according to their specific gravity. The fragments of schist and pyritic coal, being much heavier than pure coal, fall at once on the inclined bottom, and then through a grating pass into the pocket above mentioned, which is emptied from time to time by means of the valve. The fragments of pure coal escape with the water through the rectangular open-

* From the London Artizan, August, 1851.

ing, and fall upon the grating, which has an oscillating motion, which serves to project the coal into a wagon or vehicle, whilst the water escapes through the grating.

Two men would be sufficient to work a cistern of about 40 ins. high and 40 inches in diameter, and capable of washing about 20 metrical tons in the day with a force of one horse. A cistern of about 9 feet 10 ins. in diameter and depth would wash 200 tons in the day, and would require a force of 10 horses to work it. The smaller machine would cost about £80, and the larger about £400.—*Bulletin de la Société Industrielle de Mulhouse*, No. 123, p. 292.

---

*Pendulous Reciprocating Steam Engine.**

A novel and cheap steam engine has lately been invented under the above title. It is "an eccentric revolving on its own diameter," in a "cylinder" or steam chamber suspended as a pendulum, the shaft on which the eccentric piston is keyed, being the main or driving shaft, and makes upwards of 100 revolutions per minute in a thirty horse engine. The principle of this engine is similar to the ordinary engine but it works with much less friction; a thirty horse high pressure will work with one pound of steam. "An eccentric revolving on its own diameter" contains the two motions of the ordinary engine, viz., rectilinear and revolving, though so amalgamated as to be hardly distinguishable. It has been received favorably by the Lords of the Admiralty, being especially adapted for screw propulsion, from the small space it occupies and the speed that can be obtained direct. The inventors and patentees, Messrs. Shiptons & Simpson, engineers, Manchester, obtained a medal at the Exhibition of 1851, since which great improvements have been made by them.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, December 21, 1854.

Samuel V. Merrick, President, in the chair.

John F. Frazer, Treasurer.

Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Letters were read from the Virginia Mechanics' Institute, Richmond, Va.; and the Pottsville Scientific Association, at Pottsville, Penna.

Donations to the Library were received from the Royal Geographical Society, and the Institute of Actuaries, of London; J. L. Dodge, Esq., Rome, New York; the New Orleans Academy of Science, Louisiana; and Prof. John F. Frazer, and Messrs. Chas. E. Smith, and George M. Conarroe, Philadelphia.

Donations to the Cabinets were received from Messrs. Joseph Harrison, Jr., and Richard Griffith, Philadelphia.

The periodicals received in exchange for the Journal of the Institute were laid on the table.

* From the Lond. Civ. Eng. and Arch's. Jour. March, 1854.